EXERCISE PERFORMANCE AND PERCEPTION OF BREATHLESSNESS AFTER CAFFEINE INGESTION IN CYCLISTS

A Thesis
By
ERICA LARSON

Submitted to the Graduate School
at Appalachian State University
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE

May 2018

Department of Health and Exercise Science

EXERCISE PERFORMANCE AND PERCEPTION OF BREATHLESSNESS AFTER CAFFEINE INGESTION IN CYCLISTS

A Thesis
by
ERICA LARSON
May 2018

APPROVED BY:

R. Andrew Shanely, Ph.D.
Chairperson, Thesis Committee

Jonathon L. Stickford, Ph.D.
Member, Thesis Committee

Kymberly S. Fasczewski, Ph.D.
Member, Thesis Committee

Kelly J. Cole, Ph.D.
Chairperson, Department of Health and Exercise Science

Max C. Poole, Ph.D.
Dean, Cratis D. Williams School of Graduate Studies

Abstract

EXERCISE PERFORMANCE AND PERCEPTION OF BREATHLESSNESS AFTER CAFFEINE INGESTION IN CYCLISTS

Erica Larson
B.S., James Madison University
M.S., Appalachian State University

Chairperson: R. Andrew Shanely, Ph.D.

Introduction: Caffeine (CAF) is commonly ingested as an ergogenic aid among cyclists, in part, due to its effect on pain perception. CAF also may improve exercise performance by altering the perceptions related to ventilatory work and dyspnea. **Purpose:** The purpose of this study was to evaluate exercise performance, breathlessness, and leg pain perception in trained cyclists during a fixed work time trial after the ingestion of a moderate dose of caffeine. **Methods:** Nine male cyclists completed pulmonary function testing and a peak aerobic capacity test ($\dot{V}O_{2peak}$: 60.8±5.7 $ml \cdot kg^{-1} \cdot min^{-1}$). During visit two, cyclists completed a fixed-work familiarization time trial (TT) equivalent to a distance of 20-km. Subsequently, and on separate days, subjects completed in a randomized, counterbalanced order, TTs with ingestion of a placebo (TT_{PLA}) or caffeine (TT_{CAF}; 5 $mg \cdot kg^{-1}$). Elapsed time, ventilatory dynamics, and perceptual responses were measured every 10% of the distance during each TT. Data is expressed mean ± SEM. **Results:** Elapsed time was significantly reduced during TT_{CAF}

compared with TT_{PLA} (33.5±2.8 vs. 35.5±2.7 min, $p < 0.01$). RPB did not differ between TT_{CAF} and TT_{PLA} at any interval ($p = 0.755$). A main effect was observed in ventilation during TT_{CAF} when compared with TT_{PLA} ($p = 0.019$). A main effect was observed in integrated inspiratory mouth pressure during TT_{CAF} when compared with TT_{PLA} ($p = 0.040$). **Discussion:** These results demonstrate that consuming a moderate dose of caffeine enhances exercise performance and increases ventilatory work without altering RPB.

Acknowledgments

I would like to thank Dr. Jonathon Stickford, Dr. Kym Fasczewski and Dr. Andrew Shanely for the support and guidance they have provided me during this project. I would also like to thank Jayvaugh Oliver and Hannah Synder (ERPL Graduate Students) for their assistance with data collection.

Dedication

I would like to dedicate this project to my parents, Mary and Drew Larson. They have given me endless amounts of support over the years, while continuing to challenge me with my current endeavors. I am eternally grateful for you both.

Table of Contents

List of Tables

List of Figures

Foreword

This thesis will form the basis of a manuscript to be submitted to *European Journal of Applied Physiology*, an international peer-reviewed journal published by Springer; it has been formatted according to the style guide for that journal.

Chapter 1

Introduction

Background

Caffeine is a ubiquitous and legal drug that is highly popular among athletes for its known exercise performance-enhancing capabilities, as well as its negligible health-related side effects (Warren et al. 2011; Ali et al. 2016; Duncan et al., 2013; Black et al., 2015; Talanian and Spriet, 2016; Woolf et al., 2008; Astorino et al., 2012a; Paton et al. 2015; Killen et al. 2013; Tarnopolsky, 2008b). Caffeine is readily available in food and drink, rendering athletes capable of ingesting it as part of their habitual diet. In addition to habitual consumption, athletes may purposely ingest caffeine as an ergogenic aid to improve athletic or exercise performance. This is a typical practice among endurance athletes, as it may give them an extra "push" during competition (Del Coso et al., 2011; Graham 2001, McLellan et al. 2016; Higgins et al., 2016; Outram and Stewart, 2015). Caffeine can be found in coffee, energy gels such as Cliff Shot, Hammer Gel and Honey Stinger, and sports drinks and bars.

There have been studies to date in which the effects of caffeine have examined cycling performance (Glaister et al., 2015a; Talanian and Spriet, 2016; Astorino et al., 2012b; Ivy et al., 2009b; Smolka and Kumstat, 2014; Jenkins et al., 2008). Factors such as dosage, training status, time of ingestion and history of caffeine usage can affect the performance enhancing abilities of caffeine (Graham 2001; Davis and Green, 2009; Doherty and Smith, 2005; Higgins et al., 2016). This variability has led to research examining differences in performance with varying doses, distances and training status. Previous research has shown performance enhancing effects with dosage amounts between 3-6 mg/kg body weight but no established minimal or maximal guidelines have been established to produce optimal enhancements in performance (Graham, 2001; McLellan et al., 2016; Higgins et al., 2016). A moderate dose of caffeine is approximately equivalent to 5 $mg \cdot kg^{-1}$ body weight, which equates to two-three cups of coffee. One cup of coffee has approximately 80-100 mg of caffeine.

An area of research to focus on, in relation to caffeine, is its effect on perceived pain during exercise. There also exist studies that have examined caffeine ingestion on pain perception and rating of perceived exertion (RPE) during exercise (Motl et al., 2006; Backhouse et al, 2011; Killen et al., 2013; Astorino et al., 2012b; Green et al., 2017; Gliottoni et al., 2009). Caffeine increases time to fatigue through its effect on the central nervous system (Kalmar and Cafarelli, 2004) and is considered an adenosine antagonist. When it binds to the adenosine receptors it promotes the release of various neurotransmitters such as dopamine, serotonin, and epinephrine, thus leading to a modified pain perception (Davis and Green, 2009). Exercising vigorously for extended periods of time can elicit feelings of pain in some individuals. In 1979, the International Association for the Study of Pain defined pain as an “unpleasant sensory and emotional experience associated with actual or potential tissue damage, or describe in terms of such damage” (Merskey, 2002). Specifically, in cycling, pain can be felt in the quadriceps muscle group, along with other skeletal muscles within the lower extremities and lower back muscles.

Ventilation increases as a function of exercise intensity. This is due to a higher demand of oxygen by working muscles resulting in more carbon dioxide (CO_2) to be expelled from the body. Up until a certain exercise intensity, an individual may not recognize increases in ventilation needed to meet demands of the working body (Campbell and Howell, 1963). This increase in ventilation can result in an increase in perception of breathlessness while exercising. Breathlessness is defined as, “an unpleasant sensation of labored breathing” (Burki, 1987a; Burki and Lee 2010b). Cycling can elicit a feeling of breathlessness while exercising vigorously. Caffeine has been shown to reduce fatigue and effort associated with the respiratory muscles by blocking central adenosine receptors (Kawai et al., 1995), which is the same mechanism in decreasing pain perception.

There appears to be a lack of research when examining rate of perceived breathlessness during exercise and after caffeine ingestion in healthy individuals. There have been no studies to date in which these variables have been assessed during a fixed work time trial equivalent to 20-km.

Statement of the Problem

The purpose of this study is to evaluate the rate of perceived breathlessness after the ingestion of a moderate dose of caffeine in trained male cyclists, while also examining differences in pain perception and performance.

Hypotheses

The following hypotheses were tested:

Hypothesis 1: Time to complete a 20-km time trial will be decreased following caffeine ingestion compared with that following placebo ingestion.

Hypothesis 2: Ratings of perceived breathlessness (RPB) during a 20-km time trial will be similar following caffeine ingestion compared with that following placebo ingestion.

Hypothesis 3: Ratings of perceived unpleasantness (RPU) during a 20-km time trial will stay the same following caffeine ingestion compared with that following placebo ingestion.

Hypothesis 4: Ratings of perceived exertion (RPE) during a 20-km time trial will be decreased following caffeine ingestion compared with that following placebo ingestion.

Hypothesis 5: Ratings of leg muscle pain during a 20-km time trial will be decreased following caffeine ingestion compared with that following placebo ingestion.

Significance of the Study

This study will contribute to the postulated mechanisms underlying the ergogenic effect of caffeine. Discovering another potential avenue, other than decreased pain perception and increases in fat oxidation, as to how caffeine can enhance performance, is important to athletes who consume caffeine. This study will be specifically beneficial to athletes who compete in a 20-km distance. It will also be beneficial because the dosage of caffeine to be studied ($5 mg \cdot kg^{-1}$) is applicable as it is approximately the amount many cyclists, who are caffeine consumers, would drink before a competition or race.

Summary

Caffeine is an extremely popular ergogenic aid that enhances exercise performance. When athletes reach an elite level, additional gains in performance within their field are difficult to achieve. Consuming caffeine doses within WADA levels may give some athletes the additional “push” they need to improve performance.

Chapter 2

Review of Literature

Introduction

It has been well established that caffeine has the ability to enhance physical work capacity, causing many athletes to consume it before competition (Warren et al., 2011; Ali et al., 2016; Duncan et al., 2013; Black et al., 2015; Talanian and Spriet, 2016; Woolf et al., 2008; Astorino et al., 2012b; Paton et al., 2015; Killen et al., 2013). Moderate to high intensity exercise is associated with naturally occurring pain in the muscles that are activated. The sensation of pain can be described as burning, tiring, cramping, exhausting, intense and sharp (Cook et al., 1997). Caffeine has the ability to attenuate pain during exercise (Gliottoni et al., 2009; Motl et al., 2006) by acting on peripheral and central adenosine receptors throughout the body.

What is Caffeine?

The International Olympic Committee (IOC) originally banned caffeine during competition in 1962 but removed it from the list in 1972 (Weinberg and Bealer, 2001). The uncertainty of caffeine's effects led the IOC to go back and forth on their decision to ban athletes from consuming it. Due to reported bouts of caffeine abuse in sports competition, the World Anti-Doping Agency (WADA) relisted caffeine as a doping agent from 1984-2004 (Del Coso et al., 2011). To differentiate between social and performance enhancing amounts, the IOC limited the amount of consumption during competition to 12 μg/ml from 1984-2004. Due to the individual differences in caffeine clearance, caffeine is considered part of a "monitoring program" by the WADA, with no upper limit established for a positive test outcome.

The lifted ban on caffeine has led to analysis of in-competition urine caffeine levels in athletes of varying sports. Del Coso et al., (2011) measured urine levels of athletes and determined that participants from endurance sports have higher levels of caffeine than power athletes, such as gymnastics tennis or wrestling. Examining the effects of caffeine in endurance athletes, like cyclists, is important to determine and solidify its ergogenic effects.

Caffeine is ubiquitous in nature, with traces of it seen in many foods and drinks. The main dietary sources of caffeine are found in coffee, tea, mate, guarana and soft drinks (Graham, 2001). Caffeine levels vary across coffee types and are dependent on the type of bean used, brewing method and roasting time. Caffeine is a trimethylxanthine and catabolized by the liver via the cytochrome P450 system to dimenthylxanathines. The liver demethylates caffeine into three dimenthylxanthines; paraxanthine, theophylline and theobromine, which are then further catabolized. Paraxanthine is responsible for increasing lipolysis, which helps to release glycerol and fatty acids into the blood to be used as fuel (Davis and Green, 2009; Graham, 2001). Theobromine, most commonly found in cocoa, is a vasodilator and to some degree a stimulant of smooth muscle (Graham and Spriet, 1995). It was formerly used as a diuretic for the treatment of angina and hypertension. Theophylline is a bronchodilator and induces relaxation of smooth muscle within the bronchial tree (Graham and Spriet, 1995). It was formerly used to treat patients with chronic obstructive pulmonary disorder (COPD) and is currently used to treat asthma (Graham and Spriet, 1995). Paraxanthine and theophylline do not increase in the circulation to a concentration that is considered active indicating they do not have as great of an effect as theobromine (Graham and Spriet, 1995).

Mode of Action

Caffeine is similar in structure to adenosine, allowing it to bind to adenosine receptors. This mechanism blocks adenosine from attaching to the adenosine receptor. Adenosine aids in cellular energy transfer and plays a role in signaling various pathways (Ribeiro and Sebastiao, 2010). When adenosine attaches to adenosine receptors in the brain, it acts as a central nervous system depressant. This promotes sleep and vasodilation allowing for more blood flow to the brain (Ribeiro and Sebastiao, 2010).

There are four G-protein coupled adenosine receptors, A_1, A_{2a}, A_{2b} and A_3. Each receptor has a unique distribution throughout the body (McLellan et al., 2016). Adenosine receptor density varies among individuals and can increase with high amounts of caffeine intake (McLellan et al., 2016). Adenosine receptors are found in many tissues throughout the body including the brain, heart, smooth muscle, adipocytes and skeletal muscle (Graham, 2001, Higgins et al., 2016). There is difficulty in determining which tissues caffeine directly affects due to receptors being distributed throughout the body. This also makes it challenging to determine which tissues are critical in the ergogenic aid function of caffeine.

Caffeine will specifically work to block A_1 and A_{2a} adenosine receptors, a mechanism behind caffeine attenuating pain during exercise (Ribeiro and Sebastiao, 2010). A_1 and A_{2a} receptors are expressed in the brain and periphery (Ribeiro, 2010). Adenosine receptors appear to inhibit the release of neurotransmitters, such as serotonin, dopamine, and acetylcholine, in the central nervous system. Caffeine is considered an adenosine antagonist, thus, when it binds to the adenosine receptors it promotes the release of these various neurotransmitters mentioned above. Caffeine also has the ability to cross the blood brain barrier, and effect a variety of brain centers which may lead to the feelings of increased alertness and vigilance (McLellan et al., 2016).

Optimal Doses and Timing

Caffeine's popularity and abundant nature creates difficulty in ensuring it is not in athlete's circulation during competition. As previously mentioned, the IOC has established a legal limit of 12 µg of caffeine per ml of urine. This limit is high, as it allows for an acute consumption of 9 $mg \cdot kg^{-1}$ body weight (BW) of caffeine. The consumption of 9 $mg \cdot kg^{-1}$ BW is generous and forgiving to athletes who are habitual consumers. Previous research has shown performance enhancing effects with dosage amounts between 3-6 $mg \cdot kg^{-1}$ BW (Graham, 2001; McLellan et al., 2016; Higgins et al., 2016). No established minimal or maximal value of caffeine consumption has been found to produce optimal performance enhancement. Sufficient absorption time and attainment of peak circulating concentrations within the body is 60 minutes post-consumption (Graham, 2001). Conflicting research shows that caffeine may reach peak plasma concentration anywhere from 1-3 hours post-consumption (Skinner et al., 2013).

There is much variation between individuals reaching peak plasma concentration levels. Most research offers no information on plasma concentration of caffeine making it difficult to analyze (Astorino 2012; Smolka and Kumstat 2014; Jacobson et al., 1992; Wallman et al., 2010; Paton et al., 2015). More research is needed in this area to determine if there are other factors, such as training status or caffeine consumption, which may affect when peak levels are achieved.

Consuming Caffeine at Rest

While consuming caffeine at rest, there is an increase in ventilation, heart rate, blood pressure and systemic vascular resistance (Brown et al., 1993). The mechanism behind caffeine increasing ventilation is not completely understood (Kraaijenga et al., 2015). After the ingestion of caffeine, tidal volume and alveolar ventilation will increase (Williams and Parsons, 2011). Tidal volume is the amount of air breathed in and out during inhalation and exhalation (Cloutier, 2007). Alveolar ventilation is the rate of air flow that the gas exchange areas of the lung encounter during inhalation and exhalation (Cloutier, 2007). When tidal volume and alveolar ventilation increase, ventilation will become more efficient during exercise (Birnbaum, 2004). This mechanism may be due to adenosine receptor antagonism in the respiratory center. Caffeine can also improve the contractility of the diaphragm, the primary inspiratory respiratory muscle, leading to an increase in ventilation (Kraaijenga et al., 2015). The metabolizing agents of caffeine can also improve ventilation through a bronchodilating effect.

Caffeine will stimulate the central nervous system and will improve CO_2 sensitivity (Kraaijenga et al., 2015). Caffeine can increase levels of angiotensin II, a vasoconstrictor causing an increase in blood pressure. Angiotensin II also promotes the release of catecholamine’s that increase heart rate (Van Soeren et al., 1993). Blood pressure is increased by an increase in angiotensin II and epinephrine (Brown et al., 1993). The increase seen in heart rate will be related to the increase seen in blood pressure.

Habitual vs. Nonusers Response to Caffeine

There is much variability when examining responses between habitual and nonusers after the ingestion of caffeine. Gliottoni et al., (2009) examined college-aged males' quadriceps muscle pain in low and high caffeine consumers during a 30 minute cycling bout. Low caffeine consumers ($\leq$100 mg$\cdot$day^{-1}, n=12) and high caffeine consumers ($\geq$400 mg$\cdot$day^{-1}, n=13) ingested 5mg/kg of caffeine or a placebo pill and then completed the cycling bout. The results indicate that there was no significant difference in muscle pain in the low or high caffeine users (Gliottoni et al., 2009). Tarnopolsky et al., (1989a) examined metabolic and physiological differences in habitual caffeine users (200 mg/d) after a 90-minute running bout. There was no difference in VO_2, heart rate, RER, or RPE, however, plasma free fatty acid levels increased after caffeine consumption. McClaran and Wetter (2007) examined the effect of low doses of caffeine in non-habitual users during a steady state cycling bout. There was no difference in performance between the placebo and caffeine trials. After chronic consumption of caffeine, theophylline and paraxanthine have shown to decrease clearance at rest (Van Soeren,1993). The differences in plasma concentrations of dimenthylxanathines in habitual and nonusers of caffeine may contribute to the varying results seen.

Trained vs. Untrained Responses to Caffeine

There are varying results when comparing trained and untrained individuals and responses in performance after ingestion of caffeine. Caffeine may have a greater influence on trained individuals rather than untrained individuals due to a greater degree of muscle and tissues (Collomp et al., 1992; Graham, 2001). This increase in muscle and tissues would potentially allow caffeine to act on more tissues, thus producing a greater effect. In studies examining trained subjects, significantly lower respiratory exchange ratio (RER) values, after the ingestion of caffeine, have been reported (Bell et al., 2002; Costill et al., 1978; Graham and Spriet, 1995). This is indicative of a greater reliance on fatty acids as a fuel source compared to untrained individuals which may rely more on carbohydrates as fuel. This can be beneficial in cycling as the larger skeletal muscles used in the legs are more responsive to fat mobilization (Weinberg and Bealer, 2001).

Wallman et al., (2010) examined the effect of caffeine (6 $mg \cdot kg^{-1}$ BW) on ten sedentary females who were non-caffeine users, during a cycling bout. The results indicate there was no significant improvement in performance between the trials. Untrained individuals may have less muscle and tissues to respond to caffeine so it may be beneficial for them to ingest a higher dose.

A study done by Collomp et al., (1992) examined performance after acute caffeine ingestion (250mg) in trained and untrained swimmers during two 100m sprints. Caffeine only increased performance in the trained subjects. Lactate increased in both trained and untrained subjects (Collomp et al., 1992). This difference in performance may be attributed to the ergogenic effects of caffeine and an enhancement of buffering capacity in the trained individuals compared to the untrained.

Collomp et al., (1992) and Astorino et al., (2012b) examined performance after caffeine ingestion in trained and untrained subjects. The results from both studies found significant improvement of performance in the trained subjects (Collomp et al., 1992; Astorino et al., 2012b). Smolka and Kumstat (2014) examined differences in mean power output in sub-elite and elite cyclists and found that the caffeine significantly increased mean power output in the sub-elite cyclists but not in the elite cyclists. These results indicate that regardless of the dosage, caffeine is not an ergogenic aid in professional level cyclists. There is evidence to support, regardless of fitness level, caffeine aids in individuals being able to perform more work, and work for a longer period of time (Ali et al., 2016; Duncan et al., 2013; Ivy et al., 2009b; Talanian and Spriet, 2016). Further research is warranted to better understand the physiological effects of caffeine on individuals with varying fitness levels.

Physiological Mechanisms of Improving Performance

The mechanisms behind caffeine enhancing performance include adenosine receptor antagonism, direct effects on skeletal muscle and enhanced substrate availability (Graham, 2001). There are a multitude of mechanisms behind caffeine's performance enhancing abilities, which is seen in Figure 2. The decrease in perception of fatigue, during prolonged exercise, is influenced by caffeine affecting the central nervous system (Powers and Howely, 2012). As mentioned previously, caffeine acts as an adenosine receptor antagonist, resulting in decreases in pain perception, and increases arousal and locomotor activity (Davis and Green, 2009). Caffeine aids in delaying fatigue by acting as an adenosine antagonist (Preedy, 2012).

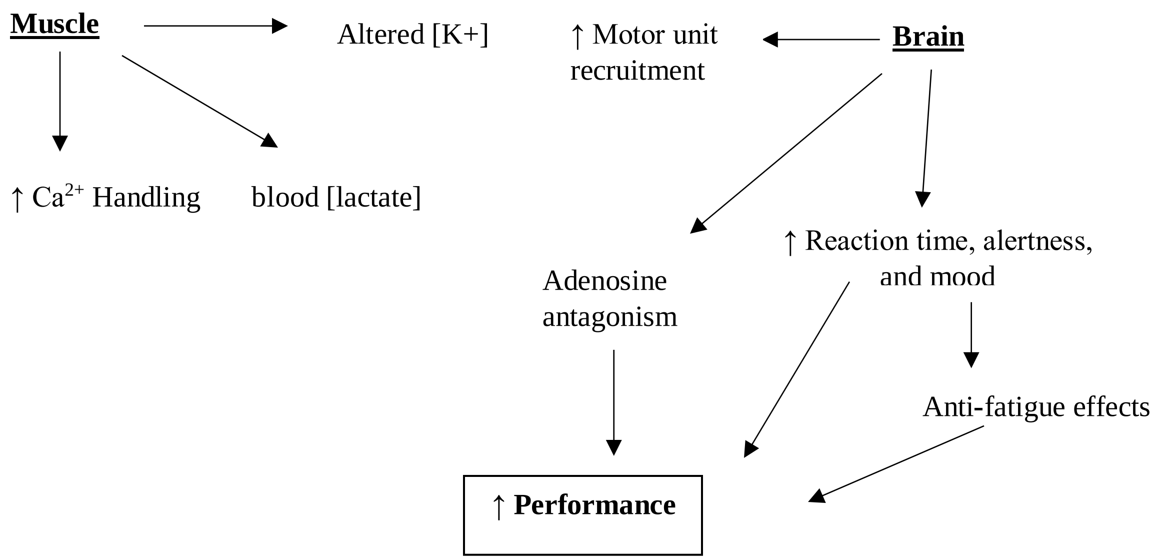

Figure 1. Proposed mechanisms for ergogenic aid of caffeine (Adaptaed from Preedy, 2012).

Caffeine may improve performance through enhanced tension development in fatigued skeletal muscle (Davis and Green, 2009). The enhancement in fatigued muscles is reported to be due to increased calcium release from ryanodine receptors. Ryanodine receptors help facilitate the release of calcium from the sarcoplasmic reticulum (Powers and Howley, 2012).

Caffeine also enhances performance through mobilization of glucose and fat (Powers and Howley, 2012). This aspect has received much attention because it is the primary means by which caffeine exerts an ergogenic aid effect (Powers and Howley, 2012). Caffeine increases levels of glucose and free fatty acid utilization through stimulation of adrenaline secretion (Graham, 2001; Higgins et al., 2016). Caffeine inhibits phosphodiesterase enzymes, which allow for an increase in intracellular cyclic adenosine monophosphate (cAMP) (Davis and Green, 2009). An increase in cAMP, would lead to greater lipolysis and fat metabolism and ultimately glycogen sparing (Davis and Green, 2009). Inhibiting phosphodiesterase will increase the power of release of catecholamine’s, which increase heart rate and blood pressure (Tavares and Sakata, 2012).

Outcomes

Three main outcomes to be examined: differences in rate of perceived breathlessness, pain perception, and performance.

Breathlessness

Feelings of breathlessness can occur when there are increases in respiratory drive or the respiratory system is exposed to mechanical load (Manning and Schwartzstein, 1995). Breathlessness is multifaceted and involves three different sensations; air hunger, work/effort and chest tightness (Nishino, 2011). Air hunger arises when there is a mismatch between pulmonary ventilation and the drive to breathe (Lansing, 2009). Work of breathing can be perceived as uncomfortable when breathing frequency or tidal volume increases above normal levels, weak respiratory muscles, and less than optimal length of the respiratory muscles (Lanstang. 2009). Chest tightness is mainly related to bronchoconstriction and is related to localized tightness within the chest or lungs (Lanstang, 2009). All of these sensations can lead to feelings of breathlessness while exercising. It has been proposed that breathlessness occurs when there is a mismatch between afferent information from the receptors of the respiratory system and the central nervous system (Manning and Schwartzstein, 1995).

Caffeine ingestion increases ventilation at rest and during exercise (Chapman and Mickleborough, 2009a). During exercise, ventilation and alveolar ventilation increase (Sheel and Romer, 2004). At lower intensities, increases in breathing frequency and tidal volume ultimately lead to pulmonary ventilation increasing. However, at higher exercise intensities, tidal volume will plateau (around 50-60% vital capacity) and ventilation rises by additional increases in breathing frequency (Sheel and Romer, 2004).

Birnbaum (2004) examined the effects of 7 $mg \cdot kg^{-1}$ BW of caffeine in 10 distance runners (n=5 M, n=5 F) during a 30-minute run at 70% of the subjects VO_2 max. Researchers found pulmonary ventilation increased during the caffeine trial, along with tidal volume and alveolar ventilation (Birnbaum, 2004). Subjects decreased breathing frequency but increased tidal volume, during the caffeine trial, which increased ventilation. This is indicative of the respiratory muscles becoming more efficient, which was related to the subjects' decrease in RPE (Birnbaum, 2004). The increase in efficiency may be due to the bronchodilating effect in which caffeine exerts.

Increases in pulmonary ventilation during exercise with ingestion of caffeine have been seen in multiple studies (D'Urzo et al., 1990; Powers et al., 1986; Chapman and Stager, 2008b). Results from other studies examining caffeine on pulmonary ventilation have shown no change in pulmonary ventilation (Tarnopolsky et al., 1989a; Sasaki et al., 1987). If there is an increase in pulmonary ventilation during exercise, this could result in increased alveolar oxygen partial pressure, which could ultimately improve arterial hemoglobin saturation and delivery of oxygen to the working skeletal muscle (Chapman and Mickleborough, 2009a). None of these studies examined specifically caffeine's influence on the subjects' perception of breathlessness.

Pain Response

Exercise can induce feelings of pain that are acute and transient, meaning these feelings will dissipate after exercise has ceased. In 1979, the International Association for the Study of Pain defined pain as an "unpleasant sensory and emotional experience associated with actual or potential tissue damage, or describe in terms of such damage" (Merskey, 2002.) This emphasizes that pain is multi-dimensional and complex in nature. The process by which information about tissue damage is sent to the central nervous system is through nociception. Nociceptors are sensory receptors that are sensitive to tissue damage. Nerve pulses are transmitted to the spinal cord and brain, via the axons of the primary afferent neurons to the dorsal horn of the spinal cord. Ingesting caffeine may attenuate this pain response while exercising, which can decrease RPE and increase the work that is achievable (Ribeiro and Sebastiao, 2010).

Keogh and Witt (2001) examined the pain response in males and females after caffeine ingestion while placing their hand in ice water. There were no significant differences in pain tolerance or threshold between the males and females in the placebo trial. Significant differences did exist in pain tolerance and threshold during the caffeine trial. This was thought to be due to an increase in stress felt by the subjects after caffeine consumption, resulting in a higher pain tolerance and threshold. However, the women exhibited a lower pain tolerance then the men during the caffeine trial (Keogh and Witt, 2001).

Performance

Caffeine is widely known as an ergogenic aid that can enhance mood, increase vigilance, delay feelings of fatigue, increase time to exhaustion, and decrease sensations of pain. Increases in aerobic performance after caffeine ingestion have been measured (Ivy et al., 2009b; Motl et al., 2006; Paton et al., 2015; Backhouse et al., 2011; Talanian and Spriet, 2016). Ivy et al., (2009) found a 4.7% increase in performance during a 1-hour cycling time trial after ingestion of 500 ml of Red Bull (160 mg of caffeine) when compared to the placebo. During the time trial, RPE was not statistically different at any time during the placebo and energy drink trial, indicating the subjects were able to exercise more intensely during the caffeine trial but with the same perception of effort. There was no difference in substrate utilization between the trials, however as exercise duration increased, fat oxidation increased and carbohydrate oxidation decreased.

Skinner et al., (2013) examined the effects of 6 $mg \cdot kg^{-1}$ BW of caffeine on 14 highly trained male cyclists during a 40km time trial and also found no statistically significant differences in RPE during the placebo and experimental trial with caffeine. However, performance improved significantly with the caffeine (Skinner et al., 2013).

Talanian and Spriet, (2016) had highly trained male and female cyclists ingest two different doses of caffeine (1.5 $mg \cdot kg^{-1}$ BW and 2.9 $mg \cdot kg^{-1}$ BW) during a 120-minute bout of exercise. Improvements in performance were measured with both doses. Unlike most other studies, blood samples were taken to measure caffeine concentrations. Caffeine concentrations were significantly higher during both doses of caffeine compared to the placebo.

Foad et al., (2008) examined the pharmacological and psychological effects of 5 $mg \cdot kg^{-1}$ of caffeine in highly trained male cyclists during a 40km time trial. All of the subjects completed 14 trials. In some of the trials, the subjects were informed they received caffeine, informed they received caffeine but was given a placebo, and they were informed they were given a placebo. The results indicate that performance was enhanced whether subjects believe they had ingested it or not (Foad et al., 2008).

Summary

The purpose of this study was to evaluate exercise performance, breathlessness, and leg pain perception in training cyclists during a fixed work time trial after the ingestion of a moderate dose of caffeine.

It was hypothesized that following caffeine consumption, subjects would perform the time trial faster, RPB and RPU would be similar and RPE and leg muscle pain would decrease.

Chapter 3

Methods

Participants

Following approval of the study from Appalachian State University Institutional Review Board (IRB# 17-0302), highly trained male cyclists 18 to 50 years old were recruited to participate in this study. Subjects were initially screened by telephone to ensure they had no prior health or medical conditions that would prevent them from completing the study. Individuals who regularly consumed a large amount of caffeine (e.g., >4 cups of coffee per day) were excluded from participation as well as individuals who consumed little to no caffeine daily (e.g., <1 cup of coffee daily). Subjects were excluded under conditions of respiratory, cardiovascular, metabolic, or renal disease, or a history of cigarette smoking greater than or equal to one-half of a pack-year. The subjects were also required to be bicycle training approximately three hours a week for the past six months. A minimum $\dot{V}O_{2peak}$ of 53 $mL \cdot kg^{-1} \cdot min^{-1}$ was met by each subject. Prior to each visit, subjects were asked to refrain from strenuous exercise (24 hours), caffeine (12 hours) and arrive in a fully rested and hydrated state.

Experimental Design

A double-blind, randomly-assigned, placebo-controlled experimental design was employed to examine the effect of caffeine on perceptual responses and exercise performance. All subjects visited the laboratory on four occasions. Subjects completed the informed consent process, a medical health history questionnaire, pulmonary function testing, and peak exercise test during the initial visit. Height and weight also were measured during the visit.

Visit two consisted of a fixed-work familiarization TT. Visits three and four consisted of subjects completing a fixed-work TT under placebo (TT_{PLA}) and caffeine (TT_{CAF}) conditions in a randomly-assigned, double-blind manner. All exercise visits were separated by a minimum of 48 hours. The total time to complete the study required by subjects was approximately 7-9 hours.

Pulmonary Function

All subjects completed spirometry and lung volume tests in a body plethysmograph (Carefusion Vmax 62J Auto Box, Yorba Linda, CA) according to ATS/ERS guidelines (European and Society 2002). Subjects performed the spirometry procedures in a seated position while breathing room air, with nasal breathing occluded by a nose clip. The procedure for all spirometry tests entailed 1) three normal tidal volume breaths, 2) maximal inhalation, 3) forced maximal exhalation, and 4) maximal inhalation. Each subject performed three acceptable spirograms. Reported values include forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), forced mid expiratory flow rate ($FEF_{25-75\%}$), and peak expiratory flow rate (PEF). Maximal voluntary ventilation (MVV) was calculated as the maximum amount of air the subject exhaled in a 12 second period reported as a minute value. Pulmonary function volumes and flow measurements are corrected to body temperature and pressure saturated (BTPS). Reported lung volumes include total lung capacity (TLC), functional residual capacity (FRC), and residual volume.

Peak Aerobic Capacity

Subjects performed an incremental exercise test on an electronically braked, computer driven cycle ergometer (Lode Excalibur, Groningen, The Netherlands) to measure maximal oxygen consumption. Subjects were initially fitted to the ergometer. The ergometer measurements were recorded to ensure consistent cycling position across all trials. Subjects were then given verbal and written descriptions of the RPE, RPB, rating of perceived unpleasantness (RPU) and leg pain scales. Written instructions were provided to the subjects for them to review prior to starting the exercise bout. The subjects were instructed to point at the number on the scale at predetermined points during each test. The number was verbally repeated to ensure the proper value was recorded. Subjects performed a 10-minute warm up, at a self-selected power output. The test protocol was explained to the subjects and further questions were answered. The mask was fitted to the subject. After a six-minute rest period, the researcher instructed the subject to begin pedaling. Subjects started at 150 watts and each 1-minute stage increased by 30 watts until volitional fatigue. Participants were instructed to keep their cadence above 70 revolutions per minute (RPM) for the duration of the test. RPE, RPB, RPU, and leg pain were collected during the last 20 seconds of each stage. Peak oxygen uptake was determined by a RER value greater than 1.15, a heart rate within 10 beats of the age-predicted maximal heart rate, and a plateau in heart rate and oxygen consumption ($\leq$150 $ml \cdot min^{-1}$) with an increase in workload (Howley, et al 1995). Subjects were required to meet at least two of the three criteria to be considered a valid $\dot{V}O_{2peak}$ test.

Protocol Familiarization

A familiarization trial was implemented to provide an opportunity for the subjects to practice rating perceptual responses during exercise and inspiratory capacity maneuvers. This trial consisted of the subjects completing a fixed amount of work requiring cyclists to cycle for a duration similar to the time required to complete 20-km.

The subjects were instructed to abstain from eating two hours prior to reporting to the laboratory. They were instructed to refrain from caffeine for 12 hours and strenuous exercise for 24 hours. These instructions were given in order to replicate the setting during the experimental trials. A 24-hour health history and caffeine recall were completed prior to testing. The subjects also completed a three-day food and training log. They were instructed to eat the same diet during the 24-hour period prior to each time trial.

Fixed-Work Time Trials

Upon arrival to the laboratory on the experimental visits, subjects were given a placebo (gluten free, white flour) or caffeine capsule (5 $mg \cdot kg^{-1}$ BW). This dosage of caffeine is considered moderate and equivalent to approximately 2-3 cups of coffee, assuming 100 mg of caffeine per cup (Graham, 2001). After ingestion, the subjects sat quietly for 60 minutes to allow for estimated peak blood caffeine concentrations to be reached (Graham, 2001). Resting lactate was measured via a finger prick (Lactate Plus, Nova Biomedical, Waltham, MA), prior to the start of the time trial. Subjects performed a 10-minute warm up, at a self-selected power. The test protocol was explained to the subjects and further questions were answered. The mask was fitted to the subject. After a brief six rest period while sitting on the bike, subjects began pedaling. Subjects were instructed to perform the fixed work time trial as fast as possible.

Previous research has shown trained cyclists averaged 70-77% of the power achieved at $\dot{V}O_{2peak}$ and completed a 20-km TT in 28-34 minutes (Tucker, 2007; Palmer, 1998). Using these parameters for power and time (75% of peak power and 1800 seconds), subjects were given a fixed amount of work to complete in an effort to simulate a 20-km time trial. They were instructed to follow the same directions given to them during the familiarization trial. RPE, RPU, RPB, and leg pain were collected every 10% of the distance completed. Lactate was measured again at 50% and immediately upon completion of the time trial. Subjects breathed through a low resistance, two-way valve (2700 Hans Rudpolph, Shawnee, KS). Expired respiratory gas exchange was analyzed continuously by an automated metabolic cart (ParvoMedics True One 2400, Sandy, Utah), and heart rate was recorded telemetrically (Polar, Kempele, Finland). The experimental trials were completed within two weeks of each other.

Metabolic, Ventilatory and Perceptual Responses

Metabolic and ventilatory variables were continuously measured at rest and during all whole-body exercise tests using open flow, indirect calorimetry. Prior to each test, the metabolic cart and CO_2 analyzer were calibrated with room air and a gas of known composition in the physiological range (approximately 16% O_2 and 4% CO_2). Metabolic data were measured over 5-s intervals throughout each time trial. Expired fraction of CO_2 ($FeCO_2$) was continuously measured from a mouthport using a second CO_2 analyzer

(VacuMed, 17630, Ventura CA) and was converted to yield $P_{ET}CO_2$. Pressure generated at the mouth was continuously measured from a second mouthport using a differential pressure transducer (Validyne MP45, Northridge CA). SpO_2 was estimated using a pulse oximeter with optodes placed on the forehead (Nellcor OxiMax, Pleasanton, CA). Data was averaged at the conclusion at each 10% interval of the time trial using the preceding 15 second data. $\dot{V}O_2$ and $\dot{V}CO_2$ were corrected to standard temperature pressure dry (STPD) conditions. RPE, RPB, RPU, and leg pain were collected at end of every 10% interval during the familiarization and experimental time trials.

Statistical Analysis

Descriptive statistics were determined for age, height, weight and body mass index (BMI) of the participants. Time to completion and average power over the entire time trial were compared using a paired *t*-test. A series of two-way analyses of variances (ANOVAs) for repeated measures on two factors (condition (2) and interval (10)) were used to examine the perceptual, ventilatory, metabolic and mechanical data. Significant main effects were further analyzed using paired *t*-test and the Bonferroni adjustment for the number of pairwise comparisons was employed. Statistical significance was set at the 0.05 alpha level, apart from the Bonferroni analyses. Subject characteristics, pulmonary function, peak VO_2, resting data prior to each time and exercise performance data are expressed as mean ± SD in tables and mean ± SEM in the figures.

Chapter 4

Results

Subject Characteristics

A total of sixteen subjects consented to participate in the study. Subjects were excluded as follows: five subjects did not meet study qualifications for $\dot{V}O_{2peak,}$ one subject presented below normal lung function and one subject withdrew from testing. Nine (n=9) subjects completed all visits of the study and were included in subsequent analyses. Anthropometric data for subjects are displayed in **Table 1**. All subjects had no history of smoking. Subjects were involved in cycling training at the time of the investigation and completed 8.6 ± 3.8 hours of cycling per week at study entry. Subjects' primary cycling disciplines included road (n=5), cyclcocross (n=2) and mountain (n=2).

Table 1. Characteristics of study participants.

Age (yr)	**Ht (cm)**	**Wt (kg)**	**BMI ($kg \cdot m^{-2}$)**
34.0 ± 11.3	181.4 ± 6.9	74.4 ± 10.9	22.5 ± 2.1

Values are mean ± SD. Ht, height; Wt, weight; BMI, body mass index

Pulmonary Function

All subjects presented pulmonary function values above the lower limits of normal according the prediction equations set forth by ATS/ERS (European and Society

2002) (**Table 2**). Additionally, subjects' lung volumes were within the predicted normal ranges (**Table 3**).

Table 2. Spirometry results of study subjects.

	Measured	**% pred**
FVC (L)	5.89 ± 1.0	106 ± 12
FEV_1 (L)	4.77 ± 0.7	107 ± 11
FEV_1/FVC (%)	81.5 ± 8.3	100 ± 9
PEF ($L \cdot s^{-1}$)	10.5 ± 1.5	101 ± 13
$FEF_{25-75\%}$ ($L \cdot s^{-1}$)	5.02 ± 1.9	119 ± 49
MVV ($L \cdot min^{-1}$)	199.8 ± 31.1	114 ± 19

Values are mean ± SD. FVC, forced vital capacity; FEV_1, forced expiratory volume in 1 sec; PEF, peak expiratory flow; $FEF_{25-75\%}$, mid-expiratory flow rates; MVV, maximal voluntary ventilation

Table 3. Lung volumes of study subjects

TLC (L) **%pred**	**FRC (L)** **%pred**	**FRC (%TLC)** **%pred**	**RV (L)** **%pred**	**RV (%TLC)** **%pred**
8.25 ± 1.31	4.19 ± 0.74	51.0 ± 6.1	2.31 ± 0.8	27.5 ± 7.5
113 ± 14	100 ± 15	100 ± 15	113 ± 32	97 ± 20

Values are mean ± SD. TLC, total lung capacity; FRC, functional residual capacity; RV, residual volume.

Peak Aerobic Capacity

$\dot{V}O_{2peak}$ values for subjects averaged 60.5 ± 5.8 mL·kg^{-1}·min^{-1}, maximal power was 387 ± 59 W, and maximal $\dot{V}_E$ was 167 ± 32 L·min^{-1}. Additional data from the $\dot{V}O_{2peak}$ test are displayed in **Table 4**.

Table 4 Metabolic data at maximal exercise

$\dot{V}O_2$ (L·min^{-1})	4.23 0.91
$\dot{V}CO_2$ (L·min^{-1})	4.83 ± 0.91
HR (beats·min^{-1})	169 ± 15
RER	1.15 ± 0.10
$\dot{V}_E/\dot{V}O_2$	39.6 ± 3.88
$\dot{V}_E/\dot{V}CO_2$	34.6 ± 2.68
f_B (breaths·min^{-1})	53.1 ± 12.3
V_T (L)	3.31 ± 0.69

Values are mean ± SD. $\dot{V}O_2$, volume of oxygen; VCO_2, volume of carbon dioxide; HR. heart rate; RER, respiratory exchange ratio; $\dot{V}_E/\dot{V}O_2$, ventilatory equivalent for oxygen; $\dot{V}_E/\dot{V}CO_2$, ventilatory equivalent for carbon dioxide; f_B, breathing frequency; V_T, tidal volume

Time Trials

There were no differences in any of the metabolic and ventilatory measurements at rest when compared with TT_{PLA} and TT_{CAF}.

Table 5. Resting data before each TT

	TT_{PLA}	TT_{CAF}
HR (beats·min^{-1})	67 ± 12	70 ± 14
VO_2 (mL·kg^{-1}·min^{-1})	4.38 ± 1.22	4.96 ± 1.74
V_E (L·min^{-1})	17.1 ± 3.2	19.6 ± 8.0
V_T (L)	1.14 ± 0.21	1.25 ± 0.33
f_B (breaths·min^{-1})	16 ± 13	15 ± 5
EELV (%TLC)	61.2 ± 7.5	59.9 ± 7.2
EILV (%TLC)	74.6 ± 8.3	75.7 ± 7.7
$\lvert IntP_m \rvert$ (cmH_2O·s·min^{-1})	20.7 ± 5.3	20.9 ± 3.39

Values are mean ± SD. HR, heart rate; $\dot{V}O_2$, volume of oxygen; V_E, ventilation; V_T, tidal volume; f_B, breathing frequency; EELV, end expiratory lung volume; TLC, total lung capacity; EILV, end inspiratory lung volume; $\lvert IntP_m \rvert$, integrated mouth pressure during inspiration

Time-to-completion during TT_{CAF} was significantly lower compared with TT_{PLA} ($p < 0.01$). Additionally, the mean power output was significantly greater during the TT_{CAF} compared with TT_{PLA} ($p < 0.05$).

Table 6. Time trial performance results

	Time-to-Completion (min:sec)	**Mean Power (W)**
TT_{CAF}	33:22 ± 2:43*	261 ± 51**
TT_{PLA}	34:57 ± 2:35	250 ± 48

Values are mean ± SD. Significance between TT_{CAF} and TT_{PLA} noted at $p < 0.01$* and $p < 0.05$**

All subjects completed TT_{CAF} (0.41 – 2.63 min) faster when comparing to TT_{PLA} as depicted in **Figure 5-1**.

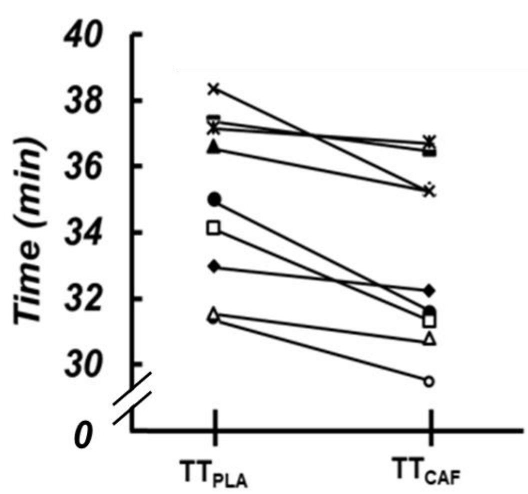

Figure 5-1. Time-to-completion during TT_{PLA} and TT_{CAF} ($p < 0.01$).

All but one subject operated at an overall higher power output (-6.8 to 23.41 W) as depicted in **Figure 5-2**.

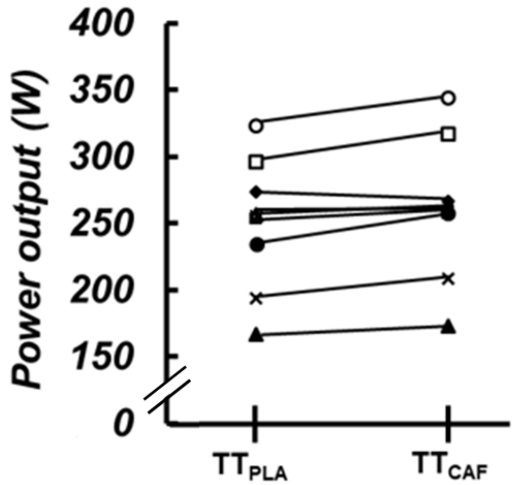

Figure 5-2. Power outputs during TT_{PLA} and TT_{CAF} ($p < 0.05$).

No condition by interval interaction [F (10, 80) = 0.848, p = 0.584] was detected for RPB. Furthermore, RPB was unaffected by caffeine ingestion [F (1, 8) = 0.104, p = 0.755)].

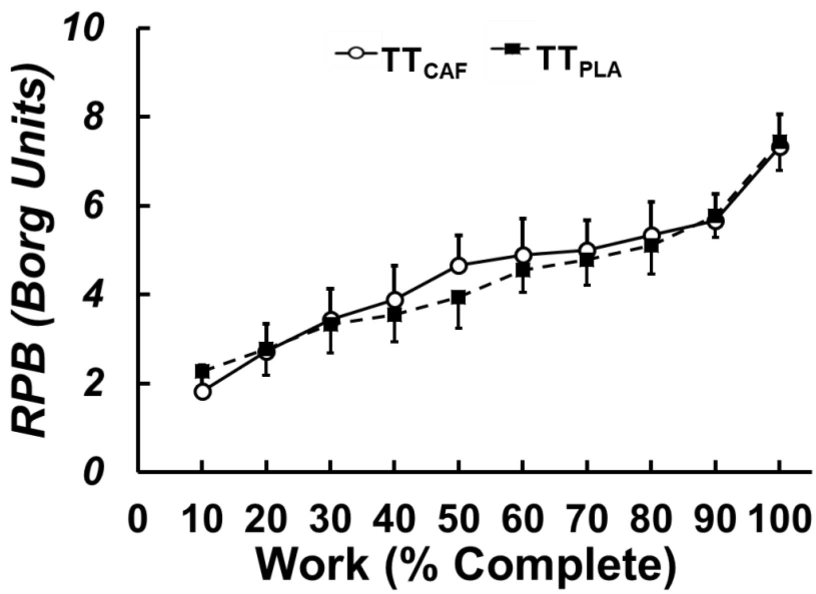

Figure 5-3. Rating of perceived breathlessness (RPB) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p=0.755).

No condition by interval interaction [F (10, 80) = 1.580, p = 0.128] was detected for RPU. Furthermore, RPU was unaffected by caffeine ingestion [F (1, 8) = 0.796, p = 0.398].

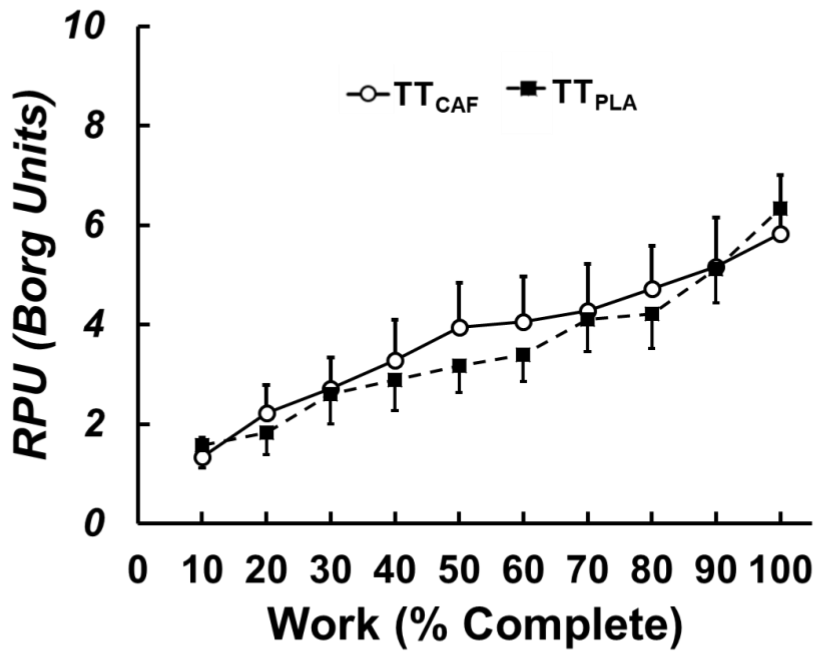

Figure 5-4. Rating of perceived unpleasantness (RPU) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p=0.398).

A condition by interval interaction [F (9, 72) = 2.34, p = 0.022] was detected for $\dot{V}_E$. Furthermore, minute ventilation was affected by caffeine ingestion [F (1, 8) = 8.65, p = 0.019]. Examination of simple main effects revealed no statistical differences in ventilation between caffeine and placebo trials at any given interval (Cohen's d = 0.54-0.80 at 20-50% of time trial completion).

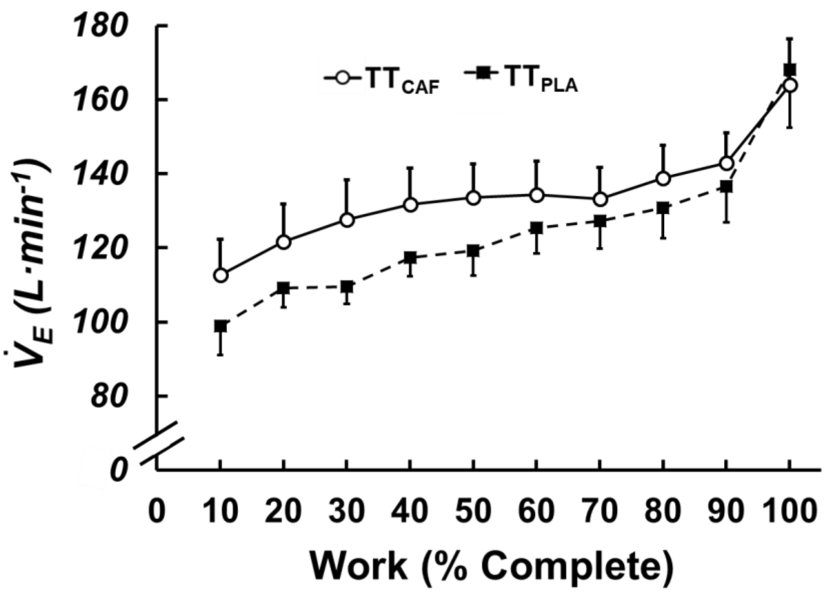

Figure 5-5. Minute ventilation ($\dot{V}_E$) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.019).

No condition by interval interaction [F (9, 72) = 0.339, p = 0.959] was detected for f_B. However, there was a main effect of caffeine on breathing frequency [F (1, 8) = 7.12, p = 0.028].

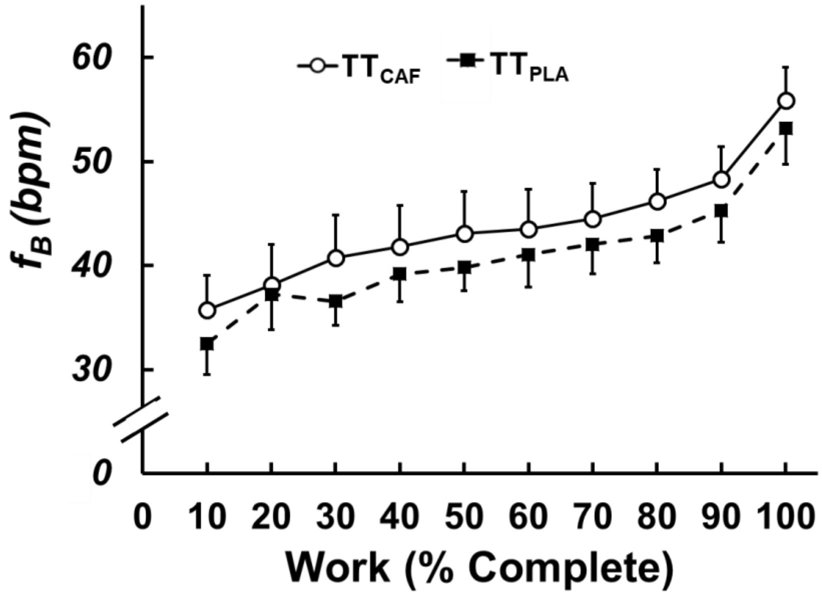

Figure 5-6. Breathing frequency (f_B) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.028).

A condition by interval was detected for V_T [F (9, 72) = 2.86, p = 0.006]. However, there was no overall main effect of caffeine on tidal volume. [F (1, 8) = 3.16, p = 0.113]. There was a significant simple main effect only at 40% (p = 0.008).

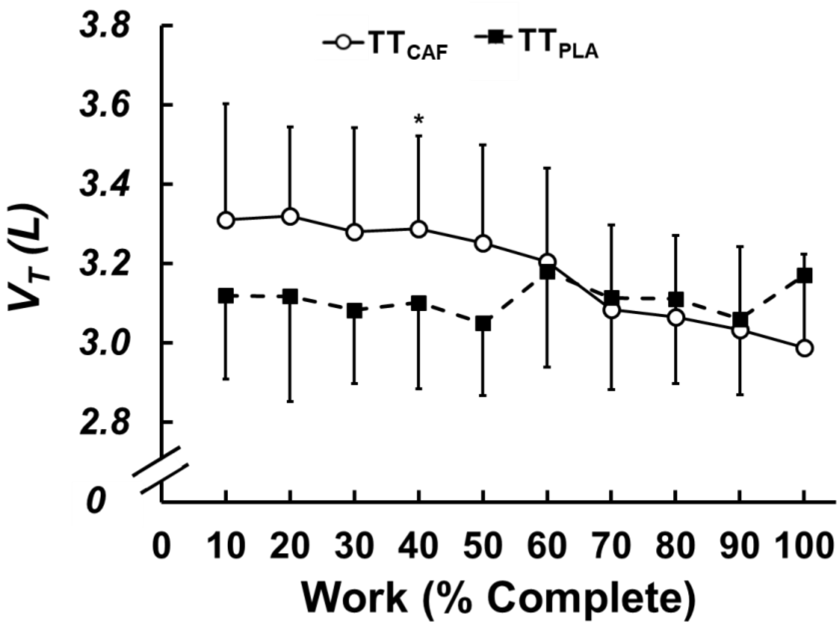

Figure 5-7. Tidal volume (V_T) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p=0.113). *Significant difference between TT_{PLA} and TT_{CAF} at the same interval ($p < 0.05$).

No condition by interval interaction was detected for $IntP_m$ [F (9, 63) = 1.72, p = 0.103]. However, there was a main effect observed in $IntP_m$ [F (1, 7) = 6.30, p = 0.040].

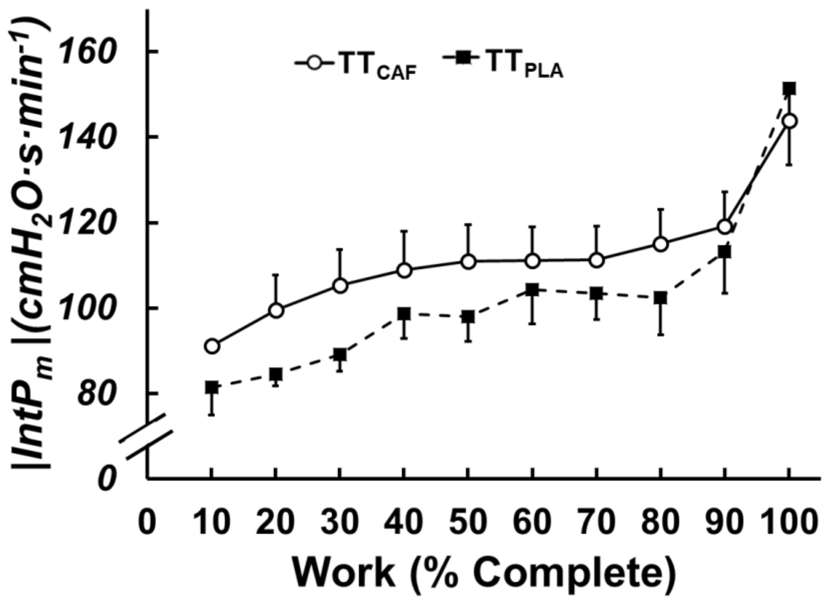

Figure 5-8. Integrated inspiratory mouth pressure ($IntP_m$) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.113).

No condition by interval interaction was detected for end expiratory lung volume expressed as a percentage of total lung capacity (EELV %TLC) [F (9, 63) = 0.995, p = 0.454]**.** Furthermore, EELV was unaffected by caffeine [F (1, 7) = 0.977, p = 0.356].

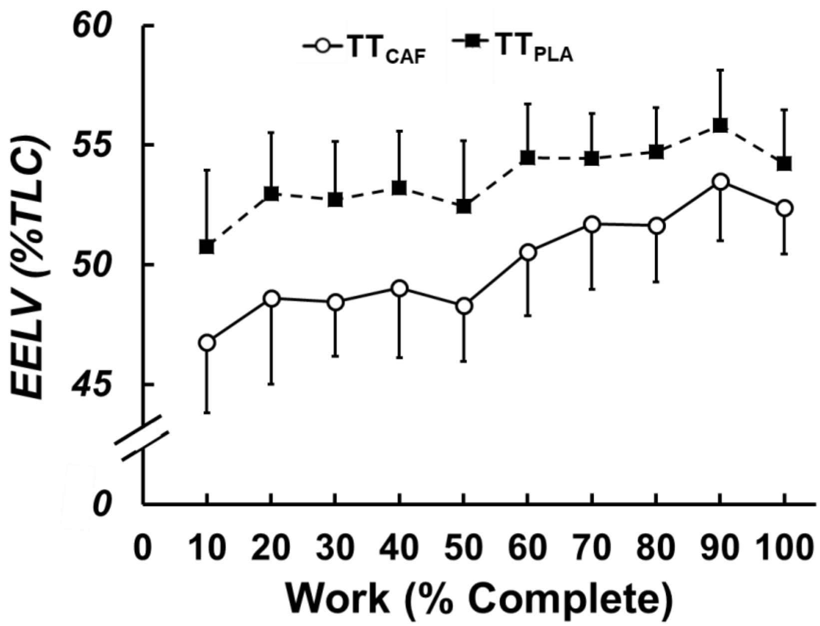

Figure 5-9. End expiratory lung volume expressed as a percentage of total lung capacity during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.356). It must be noted that one subject was not included in the analysis of lung volumes due to his inability to correctly perform inspiratory capacity maneuvers.

No condition by interval interaction was detected for end inspiratory lung volume expressed as a percentage of total lung capacity (EILV %TLC) [F (9, 63) = 1.276, p = 0.267]**.** Furthermore, EILV was unaffected by caffeine [F (1, 7) = 2.483, p = 0.159].

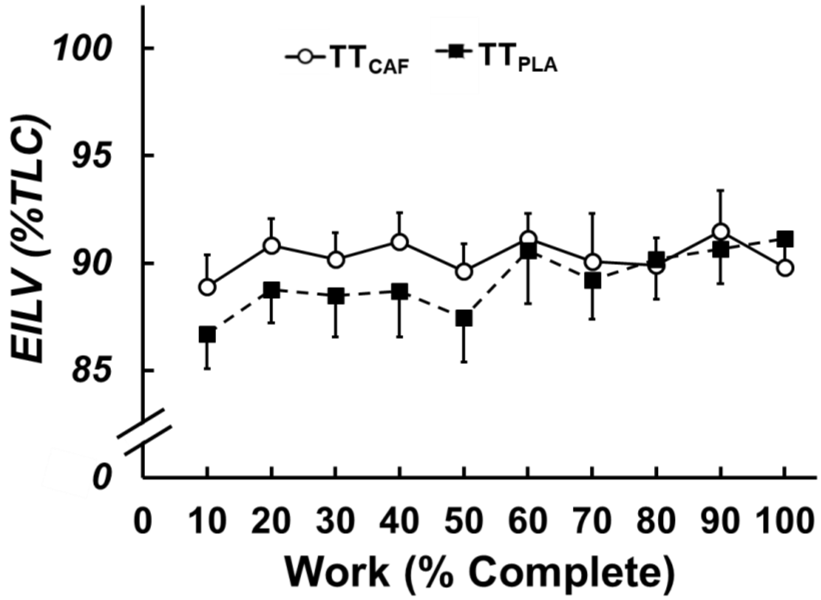

Figure 5-10. End inspiratory lung volume expressed as a percentage of total lung capacity during TT$_{PLA}$ and TT$_{CAF}$ (mean ± SEM; main effect of condition p = 0.267). It must be noted that one subject was not included in the analysis of lung volumes due to his inability to correctly perform inspiratory capacity maneuvers.

No condition by interaction was detected for $\dot{V}_E/\dot{V}O_2$ [F (10, 80) = 1.45, p = 0.173]. Furthermore, $\dot{V}_E/\dot{V}O_2$ was unaffected by caffeine ingestion [F (1, 8) = 1.39, p = 0.272)].

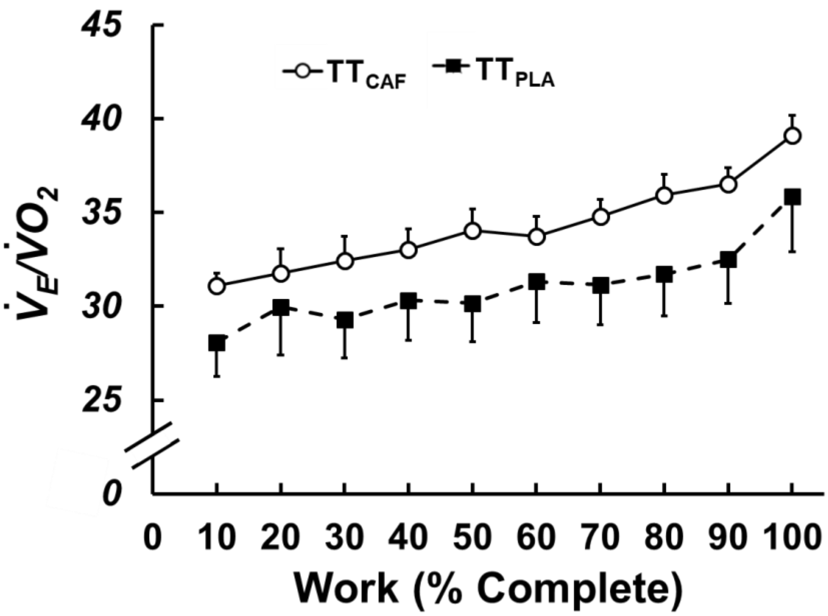

Figure 5-11. Ventilatory equivalent for oxygen ($\dot{V}_E/\dot{V}O_2$) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.272).

No condition by interval interaction was detected for $V_E/\dot{V}CO_2$ [F (10, 80) = 1.86, p = 0.063). $V_E/\dot{V}CO_2$ was unaffected by caffeine ingestion [F (1, 8) = 0.709, p = 0.424)].

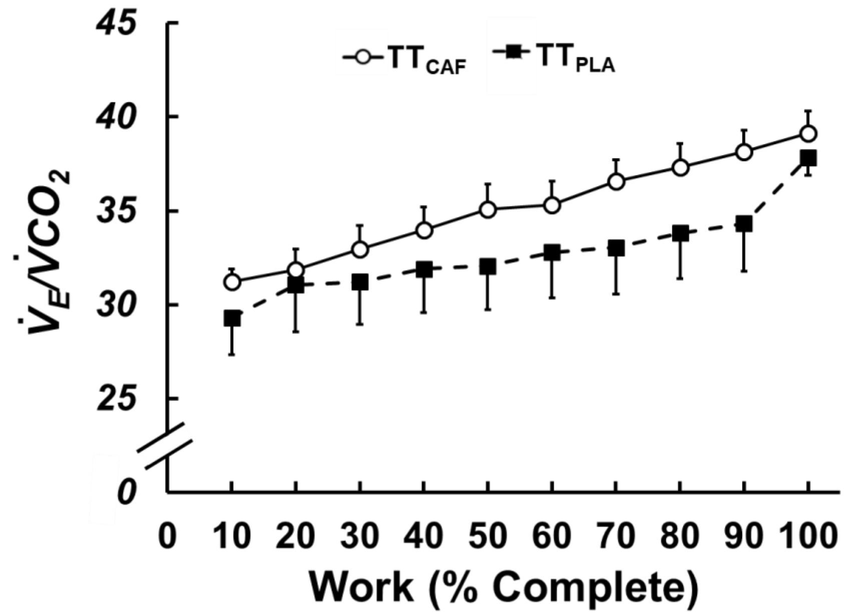

Figure 5-12. Ventilatory equivalent for carbon dioxide ($\dot{V}_E/\dot{V}CO_2$) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.424).

No condition by interval interaction was detected for $P_{ET}CO_2$ [F (10, 80) = 0.584, p = 0.823]. Furthermore, $P_{ET}CO_2$ was unaffected by caffeine ingestion [F (1, 8) = 0.527, p = 0.489)].

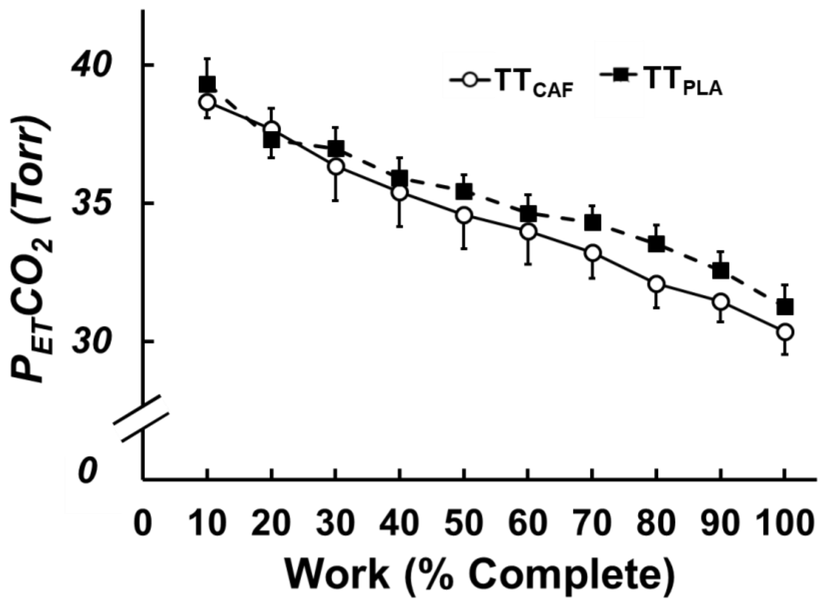

Figure 5-13. End-tidal carbon dioxide ($P_{ET}CO_2$) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.489).

No condition by interval interaction was detected for RPE [F (10, 80) = 0.823, p = 0.607]. Furthermore, RPE was unaffected by caffeine ingestion [F (1, 8) = 0.280, p = 0.611].

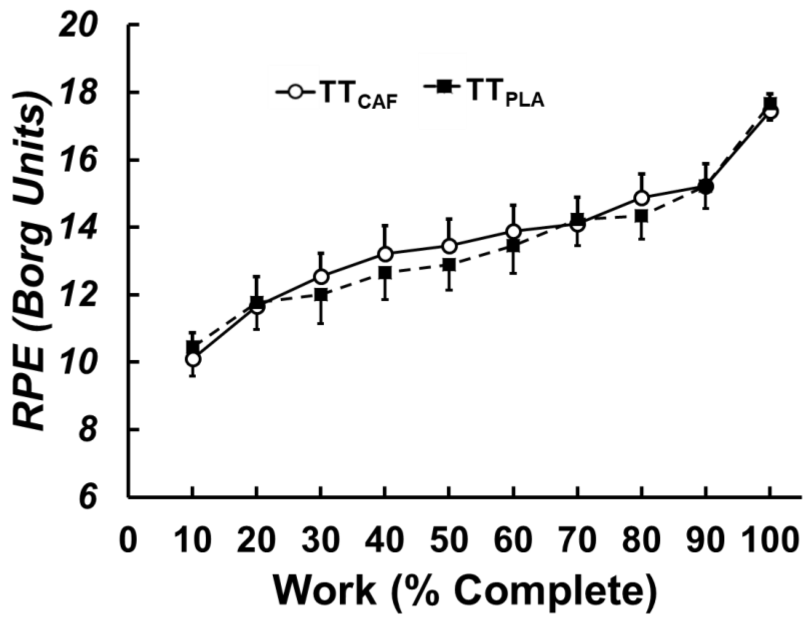

Figure 5-14. Ratings of perceived exertion (RPE) during TT$_{PLA}$ and TT$_{CAF}$ (mean ± SEM; main effect of condition p = 0.611).

No condition by interval interaction was detected for leg pain [*F* (10, 80) = 0.844, p = 0.588]. Furthermore, leg pain was unaffected by caffeine ingestion [*F* (1, 8) = 0.533, p = 0.486].

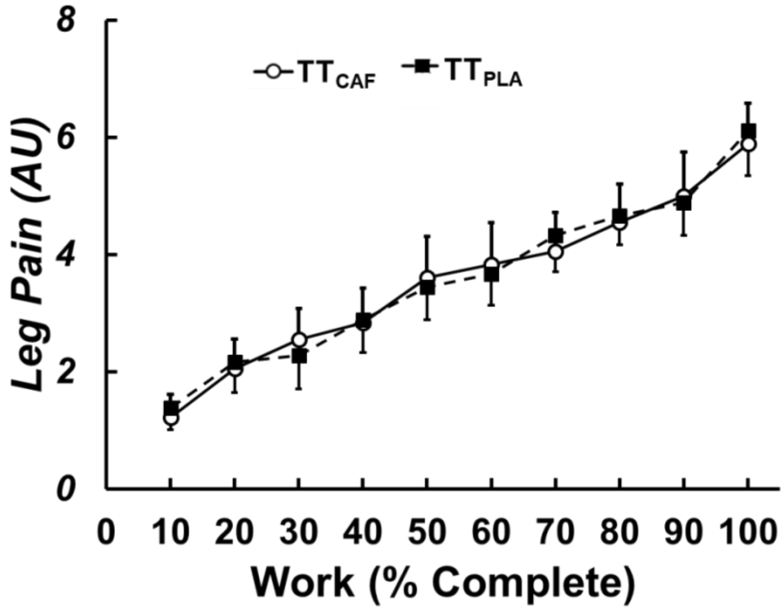

Figure 5-15. Leg pain during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.486).

No condition by interval interaction was detected for $\dot{V}O_2$ expressed as a percentage of peak [F (9, 72) = 0.993, p = 0.453]. However, there was a main effect of caffeine on oxygen consumption [F (1, 8) = 17.473, p = 0.003].

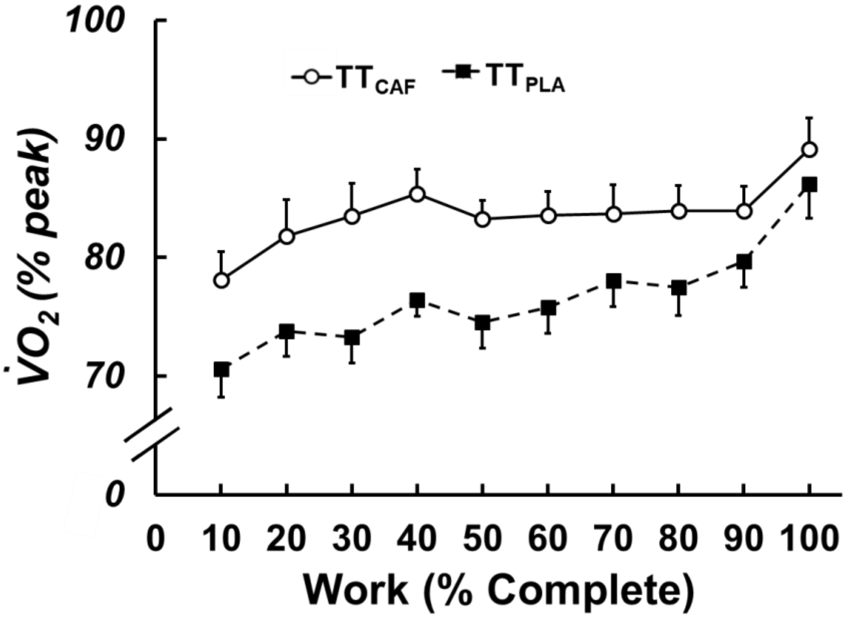

Figure 5-16. Oxygen consumption as a percentage of peak ($\dot{V}O_2$ %peak) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.003).

No condition by interval interaction was detected for power expressed as a percentage of peak [F (9, 72) = 0.786, p = 0.630]. Furthermore, power expressed as a percentage of peak was unaffected by caffeine ingestion [F (1, 8) = 2.04, p = 0.191].

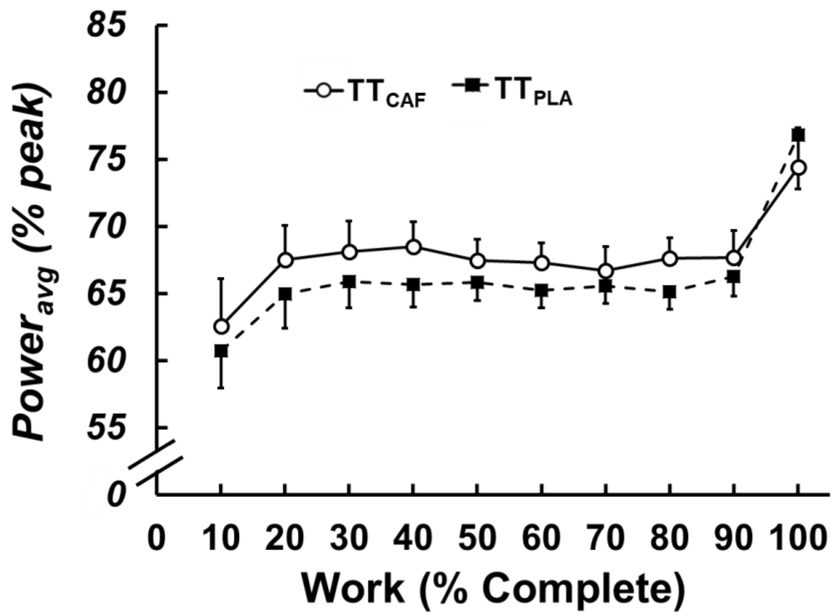

Figure 5-17. Power expressed as a percentage of peak ($power_{avg}$ (%peak)) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p=0.191)

Power was determined by two different methods. Instantaneous power was averaged during the 15-20 seconds prior to interval completion. Power was the average to complete each interval. No condition by interval interaction was detected for instantaneous power [F (9, 72) = 1.40, p = 0.204). However, there was a main effect observed in instantaneous power [F (1, 8) = 8.43, p = 0.020)].

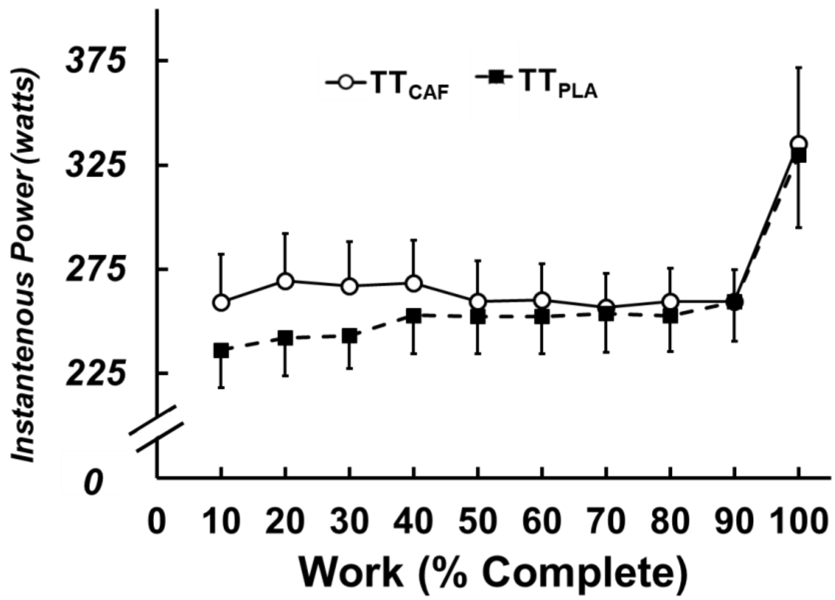

Figure 5-18. Instantaneous power during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.191) *Significant difference between TT_{PLA} and TT_{CAF} at the same interval ($p < 0.05$).

No condition by interval interaction was detected for power [*F* (9, 72) = 0.331, p = 0.962]. However, there was a main effect observed in power during caffeine trial when compared to the placebo trial [*F* (1, 8) = 6.75, p = 0.032].

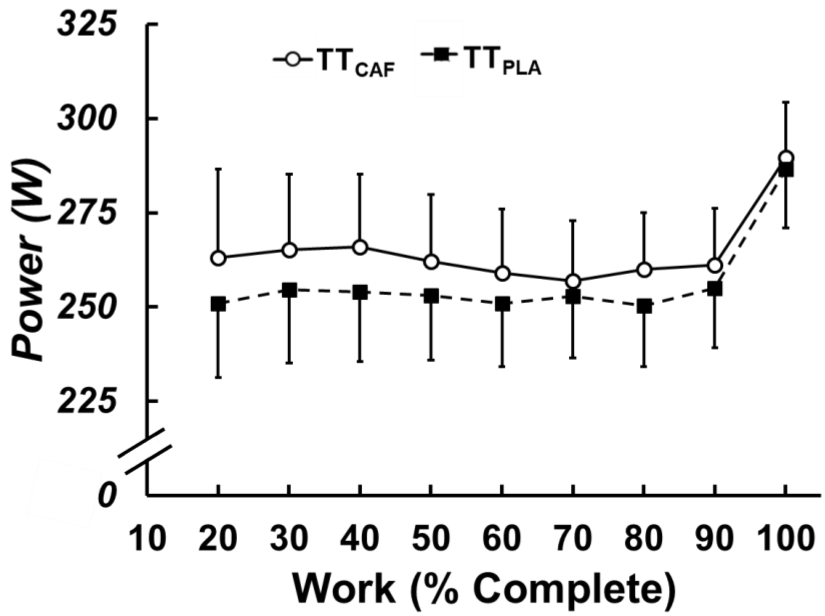

Figure 5-19. Power output during TT_{PLA} and TT_{CAF} (mean ± SEM; *significant main effect of caffeine versus placebo on power throughout the time trial p = 0.032)

There was a main effect observed in heart rate during the caffeine trial when compared to the placebo trial [F (1,7)=12.835, p = 0.009] and condition by interval interaction [F (9,63) = 3.127, p = 0.004). There were significant simple main effects at 30%, 40%, and 60% of completion during TT_{CAF} when compared to TT_{PLA}.

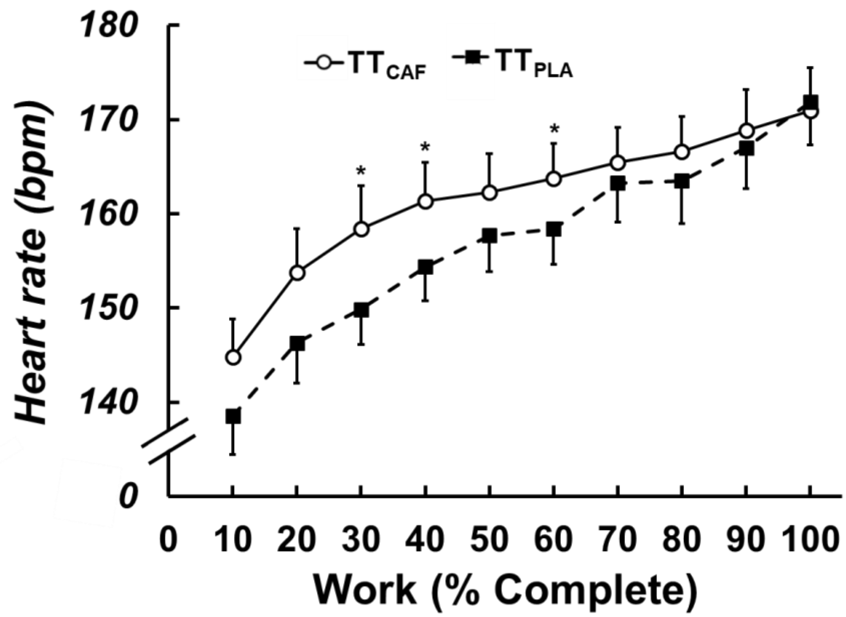

Figure 5-20. Heart rate during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p=0.009) *Significant difference between TT_{PLA} and TT_{CAF} at the same interval ($p < 0.05$).

No condition by interval interaction was detected for respiratory exchange ratio (RER) [F (10, 80) = 1.827, p = 0.069]. Furthermore, RER was unaffected by caffeine ingestion [F (1, 8) = 2.629, p = 0.144].

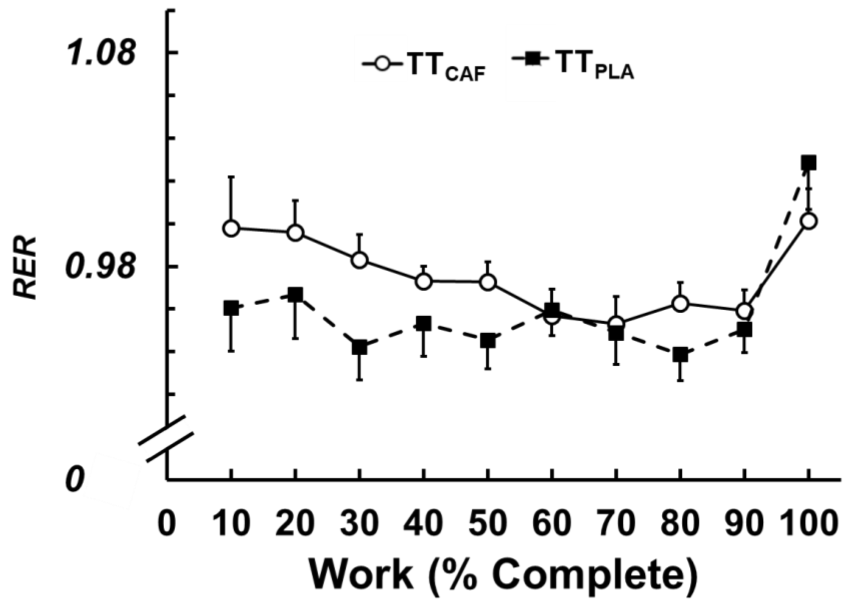

Figure 5-21. Respiratory exchange ratio (RER) during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p=0.144)

No condition by interval interaction was detected for lactate [*F* (2, 10) = 3.11, p = 0.089]. There was a main effect observed in lactate after caffeine ingestion [*F* (1, 5) = 8.651, p = 0.032].

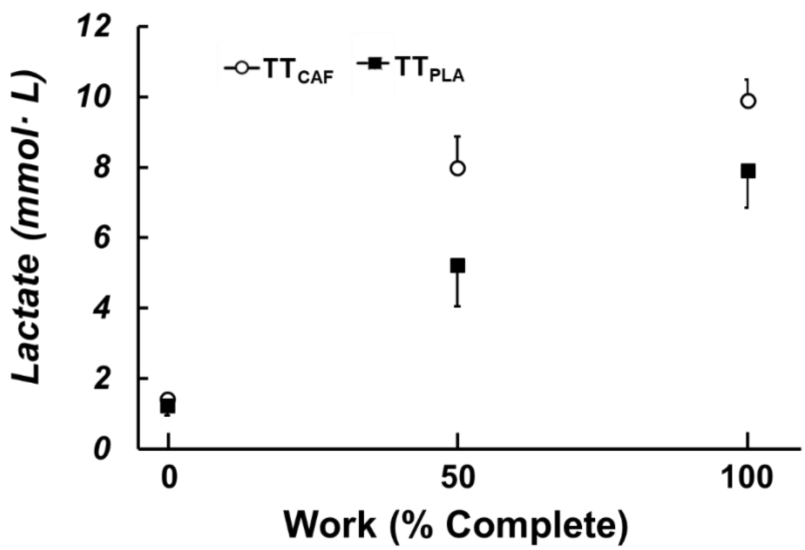

Figure 5-22. Lactate during TT_{PLA} and TT_{CAF} (mean ± SEM; main effect of condition p = 0.032). It should be noted two subjects were not included in the analysis of lactate due to insufficient assistance needed to perform lactate measurements.

Chapter 5

Discussion

The purpose of this study was to examine exercise performance and perceptual responses in well-trained, male cyclists at self-selected work rates during fixed work exercise with and without the consumption of caffeine. To our knowledge, this is the first study to examine perceptual responses in conjunction with ventilatory mechanics to determine their contribution to caffeine's ergogenic effect on exercise performance.

Caffeine significantly decreased time-to-completion. This was accomplished through a significant increase in the average power maintained throughout the TT. These data support our hypothesis that caffeine enhances exercise performance. No differences existed in RPB and RPU between TT_{CAF} and TT_{PLA}, which supported our hypotheses. However, contrary to our hypotheses, RPE and leg pain did not differ between conditions. Thus, subjects cycled at a higher power output without alteration of their perceptual responses, indicating caffeine may increase the threshold at which individuals experience breathlessness.

All subjects who participated were young, healthy individuals with a normal weight and BMI. Their medical histories were absent of any cardiovascular, metabolic, or renal diseases that would alter their performance. All subjects were habitual caffeine users and consumed approximately 100-300 mg of caffeine daily in the form of tea or coffee. At enrollment into the study, all subjects were training for their respective competition disciplines.

Pulmonary Function

All subjects had normal pulmonary function based on their age, height, and sex. Pulmonary function of all subjects was above the lower limits of normal with nearly all mean values reaching above 90% of predicted. All pulmonary function data were collected according to ATS/ERS guidelines with well-established and well-maintained equipment to ensure precise measurements.

Time Trial Protocol

The subjects were trained cyclists, thus 20-km is not an unfamiliar distance. However, not all of the subjects had specifically completed a fixed work time trial equivalent to 20-km before. This distance is applicable to the cycling field, as it is the distance used in the bike portion of a Sprint Triathlon.

No differences between conditions were observed for HR, $\dot{V}O_2$, $\dot{V}_E$, f_B, V_T or $IntP_m$ at rest. Bell et al. (1999) reported no differences in resting $\dot{V}O_2$, $\dot{V}CO_2$, $\dot{V}_E$, HR, and RER after caffeine ingestion (6 $mg \cdot kg^{-1}$ BW) in moderately trained individuals ($\dot{V}O_{2max}$ = 51 ± 8 $ml \cdot kg^{-1}$). Contrary, Powers et al., (1986) reported a significant difference in resting $\dot{V}_E$, HR and $\dot{V}CO_2$ after a dose of 7 $mg \cdot kg^{-1}$ BW of caffeine in moderately trained individuals ($\dot{V}O_{2max}$ = 53 ± 1 $ml \cdot kg^{-1}$). Differences in the caffeine dose utilized between investigations may account for the differences observed in parameters measured at rest. Further, in regards to the current study, there may have been a residual effect of the warm up period on the resting data. All subjects completed a 10-minute warm up at a self-selected pace. Within 1-2 minutes after the warm up was completed, the mask was fitted on the subjects and the six-minute resting period was initiated. A longer resting period (e.g., 10 minutes) may be needed to measure significant differences in ventilation or heart rate between conditions.

Exercise Performance

Time-to-completion significantly decreased during TT_{CAF} compared with TT_{PLA}, which equated to an approximately 4% increase in performance. This magnitude of improvement is meaningful to athletes. Average power output over the entire time trial was significantly increased during TT_{CAF}, which equated to an approximately 3% increase. All but one subject operated at a higher power output during the caffeine trial. None of the subjects performed slower during TT_{CAF}. Guest (2018) reported significant increases in endurance performance during a 10-km TT for fast metabolizers of caffeine who have the *CYP1A2* AA genotype. Subjects who were AC genotype or CC genotype were considered slow metabolizers and had impaired performance or no effect on performance. This may be a reason why one subject did not operate at a higher power output during the caffeine trial. However, determining if our subjects were fast or slow caffeine metabolizers was beyond the scope of this study.

McNaughton et al. (2008) observed a 6% increase in performance during a 20-km time trial after caffeine ingestion (6 $mg \cdot kg^{-1}$ BW). However, uphill stretches were included in the protocol, which altered their pacing strategies. Bortolotti et al., (2014) reported that caffeine ingestion (6 $mg \cdot kg^{-1}$ BW) did not significantly improve the performance of cyclists in a 20-km TT. There was an insignificant improvement of 0.46% (~10 seconds) during the caffeine trial. The researchers were unable to explain why caffeine consumption did not improve performance in their study. However, there was a difference in the training status of subjects between studies: Bortolotti et al.,

(2014) used moderately trained individuals (peak power: 345± 41 W) , while McNaughton et al., (2008) used well trained subjects (63.6 ± 4.4 mL·kg·min^{-1}). Our data are supported by the findings of McNaughton et al., (2008) whose subjects fitness level are more similar to the subjects used in this study.

The subjects in this study were considered well-trained individuals according to their $\dot{V}O_{2peak}$ values. Previous studies examining the effect of caffeine on performance in trained cyclists had subjects with average $\dot{V}O_{2max}$ of 57.5 ± 4.6 mL·kg^{-1}·min^{-1} (Cordingely 2016), 57.5 ± 3.9 mL·kg^{-1}·min^{-1} (Astorino et al., 2012b), 56.9 ± 6.6, and 66.4 ± 8.7 mL·kg^{-1}·min^{-1} (Smolka and Kumstate, 2014). Astorino et al., (2012b) examined caffeine's effect on RPE, perceptions of pain and arousal, please and displeasure in endurance trained and active men during a 10-km cycling time trial. Cycling performance significantly increased only in the trained men. However, mood significantly increased only in the active men. Smolka and Kumstat (2014) reported that caffeine significantly increased power output in sub-elite ($\dot{V}O_{2max}$ of 56.9 ± 6.6 mL·kg^{-1}·min^{-1}; training volume: 10-15 hours·week) cyclists but not in elite cyclists ($\dot{V}O_{2max}$ of 66.4 ± 8.7 mL·kg^{-1}·min^{-1}, training volume: 30-35 hours·week). This may further reiterate the fact that it is difficult for *elite* athletes to make significant improvements in their fitness once they reach the ceiling of their athletic potential. The subjects in our study were considered well-trained, but not elite, and thus caffeine elicited a significant ergogenic effect. In a study with well-trained cyclists of similar fitness status ($\dot{V}O_{2max}$ 65.0 ± 6.3 mL·kg^{-1}·min^{-1}) and caffeine ingestion (6 mg·kg^{-1} BW) McNaughton et al., (2008) concluded that cycling performance was improved significantly.

Perceptual Responses

To our knowledge, only one other study has examined RPB after caffeine ingestion in trained individuals (Hadjicharalambous et al., 2006). Their results indicate RPB was significantly lower after caffeine ingestion during a constant-load exercise on a cycle ergometer. Killen et al., (2013) examined session RPE along with RPB after caffeine ingestion (6 $mg \cdot kg^{-1}$ BW) in active men and women during a constant-load exercise on a cycle ergometer. Results indicate RPB was significantly lower, which is in agreement with Hadjicharalambous et al. (2006). These studies (Hadjicharalambous et al., 2006; Killen et al., 2013) indicate that caffeine lowers the RPE and RPB when cycling at constant power.

Subjects reported RPB and RPU to be the same between TT_{CAF} and TT_{PLA}. There was a main effect of caffeine on $\dot{V}_E$ during TT_{CAF} compared with TT_{PLA}. The increased power output and ventilation would be expected to elevate the perceptual responses. Increased f_B, rather than increased V_T, resulted in an increase in $\dot{V}_E$. This indicates subjects were implementing a ventilatory strategy that is more efficient with respect to respiratory muscle energetics. However, $\dot{V}_E$ didn't necessarily increase due to the direct effects of caffeine. $\dot{V}_E$ increased due to subjects operating at a higher power output, resulting in a higher demand for oxygen needed by the working skeletal muscles. Thus, a higher CO_2 production, which ultimately stimulates ventilation. There were no differences in $V_E/\dot{V}O_2$, $V_E/\dot{V}CO_2$, or $PetCO_2$, which would indicate that caffeine was increasing ventilation in proportion to metabolic demands.

Further, $IntP_m$, an index of work of breathing, was significantly increased during TT_{CAF} when compared with TT_{PLA} . However, caffeine may act on adenosine receptors in the respiratory muscles through the same mechanism as it does on adenosine receptors throughout the body to help attenuate leg pain or RPE. Supinksi (1986) demonstrated that a dose of 600 mg of caffeine enhances inspiratory muscle endurance while decreasing the sense of effort associated with respiratory muscle fatigue. Caffeine's effect on the central nervous system may result in a decrease of outflow from the central respiratory motor neuron pool, which would ultimately decrease the inspiratory muscle pressure during fatiguing exercise. This would ultimately result in a decrease in work of breathing and a decrease in the perception of breathlessness. $IntP_m$ was significantly increased in this current study, however, effort of breathing stayed the same during both TT's. Respiratory drive was not necessarily measured in this study. However, it can be assumed there was an increase in respiratory drive during TT_{CAF} as evidenced by the increases in $\dot{V}_E$ and $IntP_m$.

In the current study, there was a minimal effect of caffeine on V_T (V_T was significantly increased during the caffeine trial only at 40%). EILV stayed relatively the same (approximately 90% TLC) in all subjects in both TT's. Additionally, EELV was not different between conditions at any interval. These insignificant changes seen in operational lung volumes resulted in the insignificant changes seen in tidal volume. During exercise, operational lung volumes (i.e., EILV and EELV) operate under precise control but are dynamic in nature, which is advantageous during exercise. In healthy individuals, there is an increase in EILV and a decrease in EELV during exercise compared with at rest. EELV will continue to decrease with increasing exercise intensity, to a certain point, and then will increase back to resting levels (Henke et al., 1988). This mechanism (or strategy) is considered more advantageous due to the optimal length or position of the respiratory muscles, which helps decrease the work of breathing (Henke et al., 1988). This is a regulated system between respiratory effort and mechanical responses within the respiratory system. When tidal volume occurs at higher lung volumes, there is an increase in the work of breathing due to a decrease in lung compliance. A greater amount of pressure is needed to inspire but not necessarily expire. If the inspiratory muscles are also operating at a shorter length, due to operating at a higher lung volume, this may contribute to respiratory muscle fatigue, as the respiratory muscles are operating closer to their maximal force generating capacity. Previous research has shown that EELV decreases during exercise in men, which is contrary to the results seen in this study (Henke et al., 1988; Johnson et al., 1999; Guenette et al., 2007; Mota et al., 1999). However, EELV can increase with heavy exercise. From rest to completion of the time trials, in this current study, EELV gradually trended upwards.

Central chemoreceptors located within the medulla and peripheral chemoreceptors located in the carotid artery are important for controlling ventilation (Power & Howley, 2012). Carbon dioxide is a powerful stimulant of ventilation. There was a gradual decrease in PetCO2 during both TT's, however the pattern of change did not differ between the TT's.

RPE and leg pain have been widely studied in a variety of populations such as elite male athletes, trained women, nonathletic women, and sedentary men (Astorino et al., 2012b; Anderson et al., 2000; Astorino et al., 2012c; Wallman et al., 2010; Engels and Haymes, 1992). RPB, RPU, RPE and leg pain did not differ between conditions in this current study. Previous research has shown RPE to be lower during caffeine trials compared to placebo trials during constant-load exercise (Motl et al., 2006; Gliotttoni, 2009; Backhouse et al., 2011; Doherty and Smith, 2005). Contrarily, there are published reports indicating that caffeine does not alter RPE or leg pain during exhaustive exercise (Astorino et al., 2012c; Cordingley et al., 2016).

Mechanical and Metabolic Work

Oxygen consumption during TT_{CAF} was significantly greater compared with TT_{PLA}. Subjects were operating at a higher power output during TT_{CAF} so their working skeletal muscles and heart were utilizing more oxygen to perform the increased work rate. This also led to the significant increases in heart rate. There were no condition by interval interactions for power output, however there was a significant main effect. This is indicative of operating at a higher power output while maintaining a similar pacing strategy between trials.

Ivy et al., (1979a) examined performance during two hours of isokinetic cycling after ingestion of 250 mg of caffeine. Oxygen consumption was significantly increased during the caffeine trial, which supports the results from this current study. Total work performed was also significantly increased during the caffeine trial. During the first 50 minutes of the caffeine trial conducted by Ivy et al., (1979a), there was no shift of substrate utilization, as determined by the RER. This also supports this current study, as there was no significant difference in substrate utilization as measured by RER. However, during the last 60 minutes of the caffeine trial, Ivy et al., (1979a) reported significantly higher fat oxidation. Since publication of the study by Ivy et al., (1979a), there has been a plethora of studies indicating that caffeine does not decrease RER and/or increase plasma free fatty acids during vigorous exercise (Glaister et al., 2016b; Talanian and Spriet, 2016; Jenkins et al., 2008; Tarnpolsky, 1989; Graham & Spriet, 1991; Spriet, 1992).

Lactate was significantly increased during TT_{CAF} when compared to TT_{PLA}. Subjects were operating at a higher power output and a higher percentage of their $\dot{V}O_{2peak}$, indicating a greater reliance on anaerobic metabolism. Research examining caffeine and lactate primarily use incremental exercise protocols, which makes it difficult to compare the results of this current study to previously published studies. However, it should be noted that the gold standard for measuring lactate is to obtain an arterial blood sample rather than a capillary sample, which was the method used in this current study. Blood lactate measurements can be taken intravenously, directly into a syringe, or from a finger "stick" drawn into capillary tubes and then mixed (Nordstrom, 1998). Portable lactate analyzers are now available, which use a blood sample from a finger or earlobe stick. When using the finger stick for a blood sample, one may have to "milk" the finger to get an adequate sample. This may cause interstitial fluid to be introduced into the sample, thus diluting the sample (Hart et al., 2013). This may contribute to varying lactate measures obtained. The reliability and accuracy of the device used in this study may have masked the condition by interval differences in blood lactate response as well.

Limitations

The small sample size may be the main limitation of this study. Many of the variables have large effect sizes but no statistically significant differences, indicating a larger sample size is needed. Subjects were required to wear the mask for the entire duration of the TT's. Subjects could have reported perceptual responses that also accounted for the discomfort the mask. Almost all of the subjects reported the mask hindered their ability to perform the time trials and if they didn't wear the mask, their performance would have been improved. Waiting 60 minutes may not have been the optimal time for all subjects to wait prior to starting the time trial. Research has shown caffeine reaches a peak blood concentration 30-180 minutes after ingestion (Graham, 2001). There are also slow and fast metabolizers of caffeine, which is determined by a single nucleotide polymorphism on the cytochrome of the P450 gene (Guest, 2018). Determining is subjects were slow or fast metabolizers was out of the scope for this study.

Conclusion

In conclusion, the consumption of a moderate dose of caffeine results in enhanced exercise performance in trained cyclists. Improved exercise performance was accompanied by increases in ventilatory work and O_2 utilization. Despite these changes to physiological parameters, no differences in any perceptual responses were reported between conditions. These data indicate caffeine may alter the threshold at which one experiences breathlessness, ultimately resulting in an increase in performance.

References

Ali A, O'Donnell J, Foskett A, & Rutherfurd-Markwick K (2016) The influence of caffeine ingestion on strength and power performance in female team-sport players. Journal of the International Society of Sports Nutrition, 13(1), 46-55. https://doi.org/10.1186/s12970-016-0157-4

Anderson ME, Bruce CR, Fraser SF, Stepto NK, Klein R, Hopkins WG, & Hawley JA (2000) Improved 2000-meter rowing performance in competitive oarswomen after caffeine ingestion. International Journal of Sport Nutrition and Exercise Metabolism, 10(4), 464–475.

Astorino TA, Cottrell T, Lozano AT, Aburto-Pratt K, & Duhon J (2012) Increases in cycling performance in response to caffeine ingestion are repeatable. Nutrition Research, 32(2), 78–84. https://doi.org/10.1016/j.nutres.2011.12.001

Astorino TA, Cottrell T, Talhami LozanoA, Aburto-Pratt K, & Duhon J (2012) Effect of caffeine on RPE and perceptions of pain, arousal, and pleasure/displeasure during a cycling time trial in endurance trained and active men. Physiology & Behavior, 106(2), 211–217. https://doi.org/10.1016/j.physbeh.2012.02.006

Astorino TA, Roupoli LR, & Valdivieso BR (2012) Caffeine does not alter RPE or pain perception during intense exercise in active women. Appetite, 59(2), 585–590. https://doi.org/10.1016/j.appet.2012.07.008

Backhouse SH, Biddle SJ, Bishop NC, & Williams C (2011) Caffeine ingestion, affect and perceived exertion during prolonged cycling. Appetite, 57(1), 247-252.

Bell C, Kowalchuk JM, Paterson DH, Scheuermann BW, & Cunningham DA (1999) The effects of caffeine on the kinetics of O2 uptake, CO2 production and expiratory ventilation in humans during the on-transient of moderate and heavy intensity exercise. Experimental Physiology, 84(4), 761–774. https://doi.org10.1017/S0958067099017820

Bell DG, & McLellan TM (2002) Exercise endurance 1, 3, and 6 h after caffeine ingestion in caffeine users and nonusers. Journal of Applied Physiology, 93(4), 1227–1234. https://doi.org/10.1152/japplphysiol.00187.2002

Birnbaum LJ, & Herbst JD (2004) Physiologic effects of caffeine on cross-country runners. Journal of Strength and Conditioning Research, 18(3), 463–465. https://doi.org/10.1519/1533-4287(2004)18<463:PEOCOC>2.0.CO;2

Black CD, Waddell DE, & Gonglach AR (2015) Caffeine's Ergogenic Effects on Cycling: Neuromuscular and Perceptual Factors. Medicine & Science in Sports & Exercise, 47(6), 1145–1158. https://doi.org/10.1249/MSS.0000000000000513

Bortolotti H, Altimari LR, Vitor-Costa M, & Cyrino ES (2014) Performance during a 20-km cycling time-trial after caffeine ingestion. Journal of the International Society of Sports Nutrition, 11(1), 45-51. https://doi.org/10.1186/s12970-014-0045-8

Brown NJ, Ryder D, & Nadeau J (1993) Caffeine attenuates the renal vascular response to angiotensin II infusion. Hypertension, 22(6), 847–852. https://doi.org/10.1161/01.HYP.22.6.847

Burki NK (1987) Dyspnea. Lung, 165(1), 269–277. https://doi.org/10.1007/BF02714443

Burki NK, & Lee LY (2010) Mechanisms of Dyspnea. Chest, 138(5), 1196–1201. https://doi.org/10.1378/chest.10-0534

Campbell EJ, & Howell JB (1963) The sensation of breathlessness. Br. Med Bull, 19(1), 36–40.

Chapman RF, & Mickleborough TD (2009) The Effects of Caffeine on Ventilation and Pulmonary Function During Exercise: An Often-Overlooked Response. The Physician and Sportsmedicine, 37(4), 97–103. https://doi.org/10.3810/psm.2009.12.1747

Chapman RF, & Stager JM (2008) Caffeine Stimulates Ventilation in Athletes with Exercise-Induced Hypoxemia: Medicine & Science in Sports & Exercise, 40(6), 1080–1086. https://doi.org/10.1249/MSS.0b013e3181667421

Cloutier MM (2007) Respiratory physiology. Philadelphia, PA: Mosby.

Collomp K, Ahmaidi S, Chatard JC, Audran M, & Prfaut C (1992) Benefits of caffeine ingestion on sprint performance in trained and untrained swimmers. European Journal of Applied Physiology and Occupational Physiology, 64(4), 377–380. https://doi.org/10.1007/BF00636227

Cook DB, O'Connor PJ, Eubanks SA, Smith JC, & Lee M(1997) Naturally occurring muscle pain during exercise: assessment and experimental evidence: Medicine &amp Science in Sports &amp Exercise, 29(8), 999–1012. https://doi.org/10.1097/00005768-199708000-00004

Cordingley DM, Bell GJ, & Syrotuik DG (2016) Caffeine alters blood potassium and catecholamine concentrations but not the perception of pain and fatigue with a 1 km Cycling Sprint. *International Journal of Kinesiology & Sports Science*, *4*(3), 1-9. https://doi.org/10.7575/aiac.ijkss.v.4n.3p.1

Costill DL, Dalsky GP, & Fink WJ (1978) Effects of caffeine ingestion on metabolism and exercise performance. Medicine and Science in Sports, 10(3), 155–158.

Davis JK, & Green JM (2009) Caffeine and anaerobic performance: ergogenic value and mechanisms of action. Sports Medicine, 39(10), 813–832. https://doi.org/10.2165/11317770-000000000-00000

Del Coso J, Muñoz G, & Muñoz-Guerra J (2011) Prevalence of caffeine use in elite athletes following its removal from the World Anti-Doping Agency list of banned substances. Applied Physiology, Nutrition, and Metabolism = Physiologie Appliquee, Nutrition Et Metabolisme, 36(4), 555–561. https://doi.org/10.1139/h11-052

Doherty M, & Smith PM (2005) Effects of caffeine ingestion on rating of perceived exertion during and after exercise: a meta-analysis. Scandinavian Journal of Medicine and Science in Sports, 15(2), 69–78. https://doi.org/10.1111/j.1600-0838.2005.00445.x

Duncan MJ, Stanley M, Parkhouse N, Cook K, & Smith M (2013) Acute caffeine ingestion enhances strength performance and reduces perceived exertion and muscle pain perception during resistance exercise. European Journal of Sport Science, 13(4), 392–399. https://doi.org/10.1080/17461391.2011.635811

D'Urzo AD, Jhirad R, Jenne H, Avendano MA, Rubinstein I, D'Costa M, Rubenstein I (1990) Effect of caffeine on ventilatory responses to hypercapnia, hypoxia, and exercise in humans. Journal of Applied Physiology (Bethesda, Md.: 1985), 68(1), 322–328. https://doi.org/10.1152/jappl.1990.68.1.322

Engels HJ, & Haymes EM (1992) Effects of caffeine ingestion on metabolic responses to prolonged walking in sedentary males. International Journal of Sport Nutrition, 2(4), 386–396. https://doi.org/10.1123/ijsn.2.4.386

Foad AJ, Beedie CJ, & Coleman DA (2008) Pharmacological and Psychological Effects of Caffeine Ingestion in 40-km Cycling Performance: Medicine & Science in Sports & Exercise, 40(1), 158–165. https://doi.org/10.1249/mss.0b013e3181593e02

Glaister M, Pattison JR, Muniz-Pumares D, Patterson SD, & Foley P (2015) Effects of dietary nitrate, caffeine, and their combination on 20-km cycling time trial performance. Journal of Strength and Conditioning Research, 29(1), 165–174. https://doi.org/10.1519/JSC.0000000000000596

Glaister M, Williams BH, Muniz-Pumares D, Balsalobre-Fernández C, & Foley P (2016) The Effects of Caffeine Supplementation on Physiological Responses to Submaximal Exercise in Endurance-Trained Men. PLoS One, 11(8), eCollection 2016. https://doi.org/10.1371/journal.pone.0161375

Gliottoni RC, Meyers JR, Arngrímsson SÁ, Broglio SP, & Motl RW (2009) Effect of Caffeine on Quadriceps Muscle Pain during Acute Cycling Exercise in Low versus High Caffeine Consumers. International Journal of Sport Nutrition and Exercise Metabolism, 19(2), 150–161. https://doi.org/10.1123/ijsnem.19.2.150

Graham TE (2001) Caffeine and exercise. Sports medicine, 31(11), 785-807. 0112-

Graham TE, & Spriet LL (1995) Metabolic, catecholamine, and exercise performance responses to various doses of caffeine. Journal of Applied Physiology, 78(3), 867–874. https://doi.org/10.1152/jappl.1995.78.3.867

Green JM, Olenick A, Eastep C, & Winchester L (2017) Caffeine influences cadence at lower but not higher intensity RPE-regulated cycling. Physiology & Behavior, 169, 46–51. https://doi.org/10.1016/j.physbeh.2016.11.007

Guenette JA, Witt JD, McKenzie DC, Road JD, & Sheel AW (2007) Respiratory mechanics during exercise in endurance-trained men and women. The Journal of Physiology, 581(Pt 3), 1309–1322. https://doi.org/10.1113/jphysiol.2006.126466

Guest N, Corey P, Vescovi J, & El-Sohemy A (2018) Caffeine, CYP1A2 Genotype, and Endurance Performance in Athletes. Medicine and Science in Sports and Exercise. https://doi.org/10.1249/MSS.0000000000001596

Hadjicharalambous M, Georgiades E, Kilduff LP, Turner AP, Tsofliou F, & Pitsiladis YP (2006) Influence of caffeine on perception of effort, metabolism and exercise performance following a high-fat meal. Journal of Sports Sciences, 24(8), 875–887. https://doi.org/10.1080/02640410500249399

Hart S, Drevets K, Alford M, Salacinski A, & Hunt BE (2013) A method-comparison study regarding the validity and reliability of the Lactate Plus analyzer. BMJ Open, 3(2), e001899. https://doi.org/10.1136/bmjopen-2012-001899

Henke KG, Sharratt M, Pegelow D, & Dempsey JA (1988) Regulation of end-expiratory lung volume during exercise. Journal of Applied Physiology, 64(1), 135–146. https://doi.org/10.1152/jappl.1988.64.1.135

Higgins S, Straight CR, & Lewis RD (2016) The Effects of Preexercise Caffeinated Coffee Ingestion on Endurance Performance: An Evidence-Based Review. International Journal of Sport Nutrition and Exercise Metabolism, 26(3), 221–239. https://doi.org/10.1123/ijsnem.2015-0147

Howley ET, Bassett DR, & Welch HG (1995) Criteria for maximal oxygen uptake: review and commentary. Medicine and Science in Sports and Exercise, 27(9), 1292–1301.

Ivy J, Kammer L, & Ding Z (2009) Improved Cycling Time-Trial Performance After

Ingestion of a Caffeine Energy Drink. International Journal of Sport Nutrition and Exercise Metabolism, 19(1), 61–78. https://doi.org/10.1123/ijsnem.19.1.61

Ivy JL, Costill DL, Fink WJ, & Lower RW (1979) Influence of caffeine and carbohydrate feedings on endurance performance. Medicine and Science in Sports, 11(1), 6–11.

Jacobson BH, Weber MD, Claypool L, & Hunt LE (1992) Effect of caffeine on maximal strength and power in elite male athletes. British Journal of Sports Medicine, 26(4), 276–280. https://doi.org/10.1136/bjsm.26.4.276

Jenkins NT, Trilk JL, Singhal A, O'Connor PJ, & Cureton KJ (2008) Ergogenic Effects of Low Doses of Caffeine on Cycling Performance. International Journal of Sport Nutrition and Exercise Metabolism, 18(3), 328–342. https://doi.org/10.1123/ijsnem.18.3.328

Johnson BD, Weisman IM, Zeballos RJ, & Beck KC (1999) Emerging concepts in the evaluation of ventilatory limitation during exercise: the exercise tidal flow-volume loop. Chest, 116(2), 488–503. https://doi.org/10.1378/chest.116.2.488

Kalmar JM. & Cafarell E (2004) Caffeine: a valuable tool to study central fatigue in humans? Exercise and Sport Sciences Reviews, 32(4), 143–147. https://doi.org/10.1097/00003677-200410000-00004

Kawai A, Okada Y, Mückenhoff K, & Scheid P (1995) Theophylline and hypoxic ventilatory response in the rat isolated brainstem-spinal cord. Respiration Physiology, 100(1), 25–32. https://doi.org/10.1016/0034-5687(94)00124-I

Keogh E, & Witt G (2001) Hypoalgesic effect of caffeine in normotensive men and women. Psychophysiology, 38(6), 886–895. https://doi.org/10.1111/1469-8986.3860886

Killen LG, Green JM, O'Neal EK, McIntosh JR, Hornsby J, & Coates TE (2013) Effects of caffeine on session ratings of perceived exertion. European Journal of Applied Physiology, 113(3), 721–727. https://doi.org/10.1007/s00421-012-2480-z

Kraaijenga JV, Hutten GJ, de Jongh FH, & van Kaam AH (2015) The Effect of Caffeine on Diaphragmatic Activity and Tidal Volume in Preterm Infants. The Journal of Pediatrics, 167(1), 70–75. https://doi.org/10.1016/j.jpeds.2015.04.040

Lansing RW, Gracely RH, & Banzett RB (2009) The multiple dimensions of dyspnea: Review and hypotheses. Respiratory Physiology & Neurobiology, 167(1), 53–60. https://doi.org/10.1016/j.resp.2008.07.012

Manning HL, & Schwartzstein RM (1995) Pathophysiology of dyspnea. The New England Journal of Medicine, 333(23), 1547–1553. https://doi.org/10.1056/NEJM199512073332307

Mc Naughton LR, Lovell RJ, Siegler JC, Midgley AW, Sandstrom M, & Bentley DJ (2008) The effects of caffeine ingestion on time trial cycling performance. The Journal of Sports Medicine and Physical Fitness, 48(3), 320–325.

McClaran SR, & Wetter TJ (2007) Low doses of caffeine reduce heart rate during submaximal cycle ergometry. Journal of the International Society of Sports Nutrition, 4(1), 11. https://doi.org/10.1186/1550-2783-4-11

McLellan TM, Caldwell JA, & Lieberman HR (2016) A review of caffeine's effects on cognitive, physical and occupational performance. Neuroscience & Biobehavioral Reviews, 71, 294–312. https://doi.org/10.1016/j.neubiorev.2016.09.001

Merskey H (2002) Classification of chronic pain: Descriptions of chronic pain syndromes and definitions of pain terms. Seattle: IASP.

Mota S, Casan P, Drobnic F, Giner J, Ruiz O, Sanchis J, & Milic-Emili J (1999) Expiratory flow limitation during exercise in competition cyclists. Journal of Applied Physiology, 86(2), 611–616. https://doi.org/10.1152/jappl.1999.86.2.611

Motl RW, O'Connor PJ, Tubandt L, Puetz T, & Ely MR (2006) Effect of Caffeine on Leg Muscle Pain during Cycling Exercise among Females: Medicine & Science in Sports & Exercise, 38(3), 598–604. https://doi.org/10.1249/01.mss.0000193558.70995.03

Nishino T (2011) Dyspnoea: underlying mechanisms and treatment. British Journal of Anaesthesia, 106(4), 463–474. https://doi.org/10.1093/bja/aer040

Nordström L, Chua S, Roy A, & Arulkumaran S (1998) Quality assessment of two lactate test strip methods suitable for obstetric use. Journal of Perinatal Medicine, 26(2), 83–88. https://doi.org/10.1515/jpme.1998.26.2.83

Outram SM, & Stewart B (2015) Condemning and condoning: Elite amateur cyclists' perspectives on drug use and professional cycling. International Journal of Drug Policy, 26(7), 682–687. https://doi.org/10.1016/j.drugpo.2015.01.007

Paton C, Costa V, & Guglielmo L (2015) Effects of caffeine chewing gum on race performance and physiology in male and female cyclists. Journal of Sports Sciences, 33(10), 1076–1083. https://doi.org/10.1080/02640414.2014.984752

Powers SK, Dodd S, Woodyard J, & Mangum M (1986) Caffeine alters ventilatory and gas exchange kinetics during exercise. Medicine and Science in Sports and Exercise, 18(1), 101–106. https://doi.org/10.1249/00005768-198602000-00017

Powers SK, & Howley ET (2012) Exercise physiology: theory and application to fitness and performance (8th ed). New York: McGraw-Hill Humanities/Social

Sciences/Languages.

Preedy VR (Ed.) (2012) Caffeine: chemistry, analysis, function and effects. Cambridge: RSC Publ.

Rezaimanesh D, Amiri-Farsani P, & Alijani E (2011) The effect of caffeine on some cardiovascular factors in male student athletes. Procedia - Social and Behavioral Sciences, 15, 2092–2095. https://doi.org/10.1016/j.sbspro.2011.04.060

Ribeiro JA, & Sebastião AM (2010) Caffeine and Adenosine. Journal of Alzheimer's Disease, 20(s1), S3–S15. https://doi.org/10.3233/JAD-2010-1379

Sasaki H, Maeda J, Usui S, & Ishiko T (1987) Effect of sucrose and caffeine ingestion on performance of prolonged strenuous running. International Journal of Sports Medicine, 8(4), 261–265. https://doi.org/10.1055/s-2008-1025666

Sheel AW, & Romer LM (2012). Ventilation and respiratory mechanics. Comprehensive Physiology, 2(2), 1093–1142. https://doi.org/10.1002/cphy.c100046

Skinner TL, Jenkins DG, Taaffe DR, Leveritt MD, & Coombes JS (2013) Coinciding exercise with peak serum caffeine does not improve cycling performance. Journal of Science and Medicine in Sport, 16(1), 54–59. https://doi.org/10.1016/j.jsams.2012.04.004

Smolka O, & Kumstat M (2014) Caffeine intake enhances endurance performance in sub-elite but not in elite athletes. Annales Kinesiologiae,5(2), 131-140.

Spriet LL, MacLean DA, Dyck DJ, Hultman E, Cederblad G, & Graham TE (1992) Caffeine ingestion and muscle metabolism during prolonged exercise in humans. The American Journal of Physiology, 262(6 Pt 1), 891-898. https://doi.org/10.1152/ajpendo.1992.262.6.E891

Supinski GS, Levin S, & Kelsen SG (1986) Caffeine effect on respiratory muscle endurance and sense of effort during loaded breathing. Journal of Applied Physiology, 60(6), 2040–2047. https://doi.org/10.1152/jappl.1986.60.6.2040

Talanian JL, & Spriet LL (2016) Low and moderate doses of caffeine late in exercise improve performance in trained cyclists. Applied Physiology, Nutrition, and Metabolism, 41(8), 850–855. https://doi.org/10.1139/apnm-2016-0053

Tarnopolsky MA, Atkinson SA, MacDougall JD, Sale DG, & Sutton JR (1989) Physiological responses to caffeine during endurance running in habitual caffeine users. Medicine and Science in Sports and Exercise, 21(4), 418–424. https://doi.org/10.1249/00005768-198908000-00013

Tarnopolsky MA (2008) Effect of caffeine on the neuromuscular system — potential as an ergogenic aid. Applied Physiology, Nutrition, and Metabolism, 33(6), 1284–1289. https://doi.org/10.1139/H08-121

Tavares C, & Sakata RK (2012). Caffeine in the treatment of pain. Revista Brasileira De Anestesiologia, 62(3), 387–401. https://doi.org/10.1016/S0034-7094(12)70139-3

Van Soeren MH, Sathasivam P, Spriet LL, & Graham TE (1993) Caffeine metabolism and epinephrine responses during exercise in users and nonusers. Journal of Applied Physiology, 75(2), 805–812. https://doi.org/10.1152/jappl.1993.75.2.805

Wallmn KE, Goh JW, & Guelfi KJ (2010) Effects of caffeine on exercise performance in sedentary females. Journal of Sports Science & Medicine, 9(2), 183–189.

Warren GL, Park ND, Maresca RD, Mckibans KI, & Millard-Stafford ML (2010). Effect of Caffeine Ingestion on Muscular Strength and Endurance: A Meta-Analysis. Medicine & Science in Sports & Exercise, 42(7), 1375–1387.

https://doi.org/10.1249/MSS.0b013e3181cabbd8

Weinberg BA, & Bealer BK (2001) The world of caffeine: the science and culture of the world's most popular drug. New York: Routledge.

Williams JS, & Parsons SM (2011) Ventilatory and Respiratory Muscle Function at Rest and During Exercise Across the Menstrual Cycle. Journal of Exercise Physiology Online, 14(5), 109–117.

Woolf K, Bidwell WK, & Carlson AG (2008) The Effect of Caffeine as an Ergogenic Aid in Anaerobic Exercise. International Journal of Sport Nutrition and Exercise Metabolism, 18(4), 412–429.https://doi.org/10.1123/ijsnem.18.4.412

Appendices

Appendix A.a: Raw Data - Subject Information

LN	STUDY	ID	GRP	STATUS	RACE	AGE	DOB	SEX	CODE	HT (cm)	WT (kg)	BMI
1	CAB	400	MALE	COMPLETE	CAUC.	24	12/28/92	M	Mean	191.0	78.2	21.4
3	CAB	402	MALE	COMPLETE	CAUC.	19	7/4/1998	M	Mean	183.0	70.0	20.9
4	CAB	403	MALE	COMPLETE	AA	26	10/19/1990	M	Mean	173.0	56.8	19.0
5	CAB	404	MALE	COMPLETE	CAUC.	35	7/16/1982	M	Mean	173.0	69.6	23.3
6	CAB	405	MALE	COMPLETE	CAUC.	45	8/4/1972	M	Mean	175.0	72.9	23.8
7	CAB	406	MALE	COMPLETE	CAUC.	42	10/3/1972	M	Mean	192.0	92.4	25.1
12	CAB	411	MALE	COMPLETE	CAUC.	49	5/10/1968	M	Mean	174.5	68.8	22.6
15	CAB	414	MALE	COMPLETE	CAUC.	46	6/25/1971	M	Mean	174.5	67.1	22.0
16	CAB	415	MALE	COMPLETE	CAUC	20	5/20/1997	M	Mean	186.0	84.7	24.5

Hx Asth	Smoke HX	Ex	Type Ex	ExFreq (per/wk)	ExDuration (min)
NO	NO	YES	CYCLING	7	60-120
NO	NO	YES	CYCLING	7	60-120
NO	NO	YES	CYCLING	1-3	60-180
NO	NO	YES	CYCLING	3-4	120-300
NO	NO	YES	CYCLING	1-4	60-300
NO	NO	YES	CYCLING	3-4	60-120
NO	NO	YES	CYCLING	4-5	30-720
NO	NO	YES	CYCLING	2-4	60-120
NO	NO	YES	CYCLING	3	120.0

Meds	Processing
NONE	EML
NONE	EML
NONE	EML
NONE	EML
ZYRTEC	EML
NONE	EML
NONE	EML
Tamsulosin (.4mg), Glucosamine + Chondroitn +Tumeric (500mg +500mg +100mg), Probiotic, Trazodone	EML
NONE	EML

Appendix A.b: Raw Data - Pulmonary Function

ID	GRP	AGE	HT (cm)	WT (kg)	SEX	SPIRO	FVC	FVC PP NHANES	FVC P Knudson	FVC PP Knudson	FEV1	FEV1 PP NHANES	FEV1 P Knudson	FEV1 PP Knudson
400	**MALE**	24	191.0	78.2	M	Spiro	6.40	99	6.623	97	5.70	105	5.486	104
402	**MALE**	19	183.0	70.0	M	Spiro	5.67	98	6.097	93	4.54	95	5.100	89
403	**MALE**	26	173.0	56.8	M	Spiro	5.25	100	5.045	104	4.00	93	4.231	95
404	**MALE**	35	173.0	69.6	M	Spiro	5.59	110	4.776	117	5.57	135	3.968	140
405	**MALE**	45	175.0	72.9	M	Spiro	5.64	112	4.647	121	4.67	118	3.809	123
406	**MALE**	42	192.0	92.4	M	Spiro	7.67	132	6.171	124	5.24	106	5.027	104
411	**MALE**	49	174.5	68.8	M	Spiro	4.93	102	4.486	110	3.99	104	3.659	109
414	**MALE**	46	174.5	67.1	M	Spiro	4.31	88	4.575	94	3.60	104	3.746	96
415	**MALE**	20	186.0	84.7	M	Spiro	7.31	119	5.566	131	5.59	110	4.807	116

FEV1/FVC	FEV1/FVC PP Knudson	25-75%	25-75% PP	PEF	PEF PP	FET100%	MVV	MVV PP	fb	LUNG VOL	TLC	TLC P G/B	TLC PP G/B	TLC P G/B Corrected	TLC PP G/B Corrected
89.0625	10752.76	6.37	114	12.49	107	6.91	236	112	.	LungVol	7.97	8.43	95	.	.
80.07055	9572.669	3.86	92	10.48	103	6.88	193	115	.	LungVol	7.88	7.75	102	.	.
76.19048	9085.011	3.27	73	9.54	97	7.18	164	95	.	LungVol	6.71	6.71	100	5.90	114
99.64222	11994.84	9.95	245	13.25	134	6.98	254	155	.	LungVol	7.64	6.57	116	.	.
82.80142	10102.78	5.30	146	10.68	109	7.14	192	122	.	LungVol	8.37	6.61	127	.	.
68.31812	8387.246	3.40	76	10.97	96	6.69	228	116	.	LungVol	11.34	8.25	137	.	.
80.93306	9922.775	4.05	120	8.59	90	6.86	198	131	.	LungVol	8.40	6.50	129	.	.
83.52668	10200.63	3.99	113	9.34	96	6.78	158	102	.	LungVol	7.23	6.55	110	.	.
76.47059	88.53141	4.96	94	9.08	84	7.88	176	86	.	LungVol	8.69	8.02	108	.	.

TLC P ATS/ERS	TLC PP ATS/ERS	TLC P ATS/ERS Corrected	TLC PP ATS/ERS Corrected	Vtg	FRC PL	FRC %TLC	Pred FRC %TLC	PP FRC %TLC	FRC Pred G/B	FRC PP G/B	FRC P G/B Corrected	FRC PP G/B Corrected	FRC P ATS/ERS	FRC PP ATS/ERS	FRC P ATS/ERS Corrected	FRC PP ATS/ERS Corrected
8.18	97	.	.	4.52	4.11	51.57	48.84	105.59	4.71	87	.	.	3.60	114	.	.
7.54	104	.	.	4.02	4.94	62.69	47.79	131.18	4.33	114	.	.	3.36	147	.	.
6.74	100	5.93	113	3.59	3.20	47.69	49.26	96.81	3.94	81	3.47	92	3.19	100	2.81	114
6.74	113	.	.	4.47	4.32	56.54	51.15	110.55	3.63	119	.	.	3.27	132	.	.
6.90	121	.	.	4.95	4.03	48.15	53.25	90.42	3.69	109	.	.	3.41	118	.	.
8.26	137	.	.	7.02	5.33	47.00	52.62	89.32	4.46	119	.	.	3.78	141	.	.
6.86	122	.	.	5.53	4.47	53.21	54.09	98.38	3.75	119	.	.	3.43	130	.	.
6.86	105	.	.	3.96	3.01	41.63	53.46	77.88	3.79	79	.	.	3.41	88	.	.
7.78	112	.	.	4.61	4.34	49.94	48.00	104.05	4.19	104	.	.	3.44	126	.	.

ERV	RV	RV P G/B	RV PP G/B	RV P G/B Corrected	RV PP G/B Corrected	RV P ATS/ERS	RV PP ATS/ERS	RV P ATS/ERS Corrected	RV PP ATS/ERS Corrected	RV/TLC	VC	VC PP	IC	IC P G/B	IC PP G/B
2.74	1.27	2.12	60	.	.	1.80	71	.	.	16	6.70	104	3.86	3.72	104
2.33	2.09	1.82	115	.	.	1.59	132	.	.	27	5.88	122	3.56	3.42	104
1.77	1.42	1.67	85	1.55	92	1.61	88	1.50	95	21	5.29	101	3.51	2.76	127
1.96	2.42	1.82	133	.	.	1.81	134	.	.	32	5.22	102	3.18	2.94	108
1.29	2.84	2.04	139	.	.	2.05	138	.	.	34	5.53	110	4.23	2.92	145
1.56	3.77	2.45	154	.	.	2.21	171	.	.	33	7.57	121	5.33	3.79	141
1.22	3.09	2.10	147	.	.	2.13	145	.	.	37	5.31	110	3.94	2.75	143
0.52	2.18	2.05	107	.	.	2.07	105	.	.	30	5.05	103	4.22	2.75	153
2.86	1.59	1.92	83	.	.	1.65	97	.	.	18	7.10	115	4.35	3.83	114

IC P G/B Corrected	IC PP G/B Corrected	IC P ATS/ERS	IC PP ATS/ERS	IC P ATS/ERS Corrected	IC PP ATS/ERS Corrected	Raw	Raw PP	Gaw	Gaw PP	sRaw	sRaw PP	sGaw	sGaw PP
.	.	4.59	84	.	.	1.12.	124	0.893	79	5.00	118	0.200	85
.	.	4.18	85	.	.	1.98	202	0.506	56	7.43	200	0.135	50
2.43	144	3.55	99	3.12	112	2.54	233	0.393	41	9.14	211	0.190	47
.	.	3.47	92	.	.	1.10	90	0.908	103	4.92	110	0.203	90
.	.	3.49	121	.	.	1.36	114	0.735	101	6.74	151	0.148	65
.	.	4.48	119	.	.	2.08	115	0.481	45	14.59	341	0.069	29
.	.	3.43	115	.	.	1.45	120	0.692	78	8.00	180	0.125	56
.	.	3.46	122	.	.	1.03	88	0.968	107	4.09	92	0.244	108
.	.	4.34	100	.	.	2.80	273	0.357	35	12.92	299	0.077	33

Appendix A.c: Raw Data - $\dot{V}O_{2peak}$

ID	GRP	Stage	TLC	FRC	FVC	MVV	P_B	V_E IET	V_T IET	f_B IET	VO_2 IET	VO_2 ml/kg IET	Peak VO_2 IET	PerVO_2 IET	VCO_2 IET	RER IET	V_E/VO_2 IET	V_E/VCO_2 IET	Pred WT IET	PVO_2 PWT IET	$PPVO_2$ PWT IET	PVO_2+C PWT IET	$PPVO_2$+C PWT IET	HR IET	PHR IET	HR PP IET	O2Pul IET
400	MALE	REST	7.97	4.11	6.48	236	676	18.6442	1.23549	15.0905	0.48515	6.2	5.14013	9.44	0.45673	0.94	38.43	40.82	90.19	3.270	14.834	3.199	15.168	69	201	0.34	7.031
400	MALE	150	7.97	4.11	6.48	236	676.0	45.116	1.96778	22.9274	1.67897	21.5	5.14	32.66	1.39979	0.83	26.87	32.23	90.19	3.270	51.337	3.199	52.492	130	201	0.65	12.915
400	MALE	180	7.97	4.11	6.40	236	676.0	60.1136	2.51517	23.9004	2.445	31.3	5.14	47.57	2.09692	0.86	24.59	28.67	90.19	3.270	74.760	3.199	76.441	133	201	0.66	18.383
400	MALE	210	7.97	4.11	6.40	236	676.0	65.7664	2.72565	24.1287	2.69971	34.5	5.14	52.52	2.40512	0.89	24.36	27.34	90.19	3.270	82.548	3.199	84.404	139	201	0.69	19.422
400	MALE	240	7.97	4.11	6.40	236	676.0	78.9775	2.86708	27.5463	3.03214	38.8	5.14	58.99	2.83125	0.93	26.05	27.89	90.19	3.270	92.712	3.199	94.797	146	201	0.72	20.768
400	MALE	270	7.97	4.11	6.40	236	676.0	87.8053	2.9766	29.4985	3.37831	43.2	5.14	65.72	3.18393	0.94	25.99	27.58	90.19	3.270	103.297	3.199	105.620	154	201	0.76	21.937
400	MALE	300	7.97	4.11	6.40	236	676.0	99.2761	3.18164	31.2028	3.70562	47.4	5.14	72.09	3.62331	0.98	26.79	27.40	90.19	3.270	113.305	3.199	115.853	159	201	0.79	23.306
400	MALE	330	7.97	4.11	6.40	236	676.0	109.859	3.23007	34.0113	3.91965	50.1	5.14	76.26	3.94268	1.01	28.03	27.86	90.19	3.270	119.849	3.199	122.545	163	201	0.81	24.047
400	MALE	360	7.97	4.11	6.40	236	676.0	130.02	3.41701	38.0507	4.38756	56.1	5.14	85.36	4.55408	1.04	29.63	28.55	90.19	3.270	134.156	3.199	137.174	170	201	0.84	25.809
400	MALE	390	7.97	4.11	6.40	236	676.0	147.277	3.43075	42.9285	4.62117	59.1	5.14	89.90	4.94427	1.07	31.87	29.79	90.19	3.270	141.299	3.199	144.477	172	201	0.85	26.867
400	MALE	420	7.97	4.11	6.40	236	676.0	177.14	3.59161	49.3206	4.9872	63.8	5.14	97.02	5.59467	1.12	35.52	31.66	90.19	3.270	152.491	3.199	155.921	177	201	0.88	28.176
400	MALE	450	7.97	4.11	6.40	236	676.0	196.034	3.66536	53.483	5.14013	#REF!	5.14	100.00	5.93476	1.15	38.14	33.03	#REF!	0.000	#DIV/0!	#REF!	#REF!	180	#REF!	#REF!	28.556
402	MALE	REST	7.88	9.94	5.84	193	682.0																				
402	MALE	150	7.88	4.94	5.67	193	682.0	38.5141	1.19373	32.2637	1.34555	19.2	5.26979	25.53	1.0873	0.81	28.62	35.42	83.87	3.058	44.005	2.975	45.236	114	207	0.55	11.803
402	MALE	180	7.88	4.94	5.67	193	682.0	59.3749	1.88403	31.5147	2.5517	36.5	5.27	48.42	2.07522	0.81	23.27	28.61	83.87	3.058	83.451	2.975	85.785	128	207	0.62	19.935
402	MALE	210	7.88	4.94	5.67	193	682.0	61.3969	2.05373	29.8954	2.57028	36.7	5.27	48.77	2.26123	0.88	23.89	27.15	83.87	3.058	84.058	2.975	86.410	128	207	0.62	20.080
402	MALE	240	7.88	4.94	5.67	193	682.0	74.8961	2.22008	33.7357	2.99772	42.8	5.27	56.89	2.76128	0.92	24.98	27.12	83.87	3.058	98.037	2.975	100.780	143	207	0.69	20.963
402	MALE	270	7.88	4.94	5.67	193	682.0	84.6842	2.22073	38.1335	3.19069	45.6	5.27	60.55	3.0651	0.96	26.54	27.63	83.87	3.058	104.348	2.975	107.267	149	207	0.72	21.414
402	MALE	300	7.88	4.94	5.67	193	682.0	100.014	2.51034	39.8406	3.49176	49.9	5.27	66.26	3.54718	1.02	28.64	28.20	83.87	3.058	114.194	2.975	117.389	162.5	207	0.79	21.488
402	MALE	330	7.88	4.94	5.67	193	682.0	119.861	2.78049	43.1078	3.87268	55.3	5.27	73.49	4.11259	1.06	30.95	29.14	83.87	3.058	126.652	2.975	130.195	172	207	0.83	22.516
402	MALE	360	7.88	4.94	5.67	193	682.0	143.319	3.01427	47.5468	4.06698	58.1	5.27	77.18	4.54095	1.12	35.24	31.56	83.87	3.058	133.006	2.975	136.727	180	207	0.87	22.594
402	MALE	390	7.88	4.94	5.67	193	682.0	163.58	2.94737	55.5005	4.32627	61.8	5.27	82.10	4.94829	1.14	37.81	33.06	83.87	3.058	141.486	2.975	145.444	186	207	0.90	23.260
402	MALE	Max	7.88	4.94	5.67	193	682.0	171.37	3.10284	55.2301	4.42357	63.2	5.27	83.94	5.26979	1.19	38.74	32.52	83.87	3.058	144.668	2.975	148.715	189	207	0.91	23.405
	MALE	REST																									
403	MALE	150	6.71	3.20	5.25	164	684.0	30.4894	2.55772	11.9205	1.23908	21.8	2.91	42.51	1.04579	0.84	24.61	29.15	75.97	2.333	53.106	2.218	55.860	150	199	0.75	8.261
403	MALE	180	6.71	3.20	5.25	164	684.0	47.2386	2.6537	17.801	1.98706	35.0	2.91	68.17	1.88119	0.95	23.77	25.11	75.97	2.333	85.163	2.218	89.579	159	199	0.80	12.497
403	MALE	210	6.71	3.20	5.25	164	684.0	61.7954	2.86272	21.5863	2.22223	39.1	2.91	76.24	2.47575	1.11	27.81	24.96	75.97	2.333	95.243	2.218	100.181	168	199	0.84	13.228
403	MALE	240	6.71	3.20	5.25	164	684.0	76.8284	3.1585	24.3243	2.5656	45.2	2.91	88.02	3.06621	1.20	29.95	25.06	75.97	2.333	109.959	2.218	115.661	173	199	0.87	14.830
403	MALE	Max	6.71	3.20	5.25	164	684.0	133.404	3.64699	36.5792	2.91478	51.3	2.91	100.00	4.06451	1.39	45.77	32.82	75.97	2.333	124.925	2.218	131.402	181	199	0.91	16.104
404	MALE	REST	7.64	4.32	5.59	254	.	.	.	.	.	#VALUE!	.	#VALUE!	.	#VALUE!	#VALUE!	#VALUE!	75.97	2.626	#VALUE!	2.588	#VALUE!	.	190	#VALUE!	#VALUE!
404	MALE	150	7.64	4.32	5.59	254	682.0	38.2513	1.55555	24.5902	1.44464	20.8	3.24	44.64	1.06827	0.74	26.48	35.81	75.97	2.626	55.013	2.588	55.825	119.5	190	0.63	12.089
404	MALE	180	7.64	4.32	5.59	254	682.0	53.0945	1.87316	28.3449	2.13648	30.7	3.24	66.02	1.64033	0.77	24.85	32.37	75.97	2.626	81.358	2.588	82.560	129.5	190	0.68	16.498
404	MALE	210	7.64	4.32	5.59	254	682.0	63.5511	2.02817	31.3342	2.39311	34.4	3.24	73.95	1.96641	0.82	26.56	32.32	75.97	2.626	91.131	2.588	92.477	137	190	0.72	17.468
404	MALE	240	7.64	4.32	5.59	254	682.0	74.3934	2.21867	33.5306	2.70428	38.9	3.24	83.57	2.31957	0.86	27.51	32.07	75.97	2.626	102.981	2.588	104.502	146	190	0.77	18.522
404	MALE	270	7.64	4.32	5.59	254	682.0	88.7052	2.4435	36.3025	3.06329	44.0	3.24	94.66	2.74768	0.90	28.96	32.28	75.97	2.626	116.652	2.588	118.375	154	190	0.81	19.891
404	MALE	300	7.64	4.32	5.59	254	682.0	103.783	2.60841	39.7878	3.33341	47.9	3.24	103.01	3.11189	0.93	31.13	33.35	75.97	2.626	126.938	2.588	128.813	159	190	0.84	20.965
404	MALE	330	7.64	4.32	5.59	254	682.0	123.282	2.78224	44.3102	3.68462	52.9	3.24	113.86	3.56724	0.97	33.46	34.56	75.97	2.626	140.313	2.588	142.385	166	190	0.88	22.197
404	MALE	360	7.64	4.32	5.59	254	682.0	147.355	3.01225	48.9185	3.98762	57.3	3.24	123.23	4.09111	1.03	36.95	36.02	75.97	2.626	151.851	2.588	154.094	171	190	0.90	23.319
404	MALE	Max	7.64	4.32	5.59	254	682.0	177.478	3.23601	54.8446	4.25542	61.1	3.24	131.50	4.7342	1.11	41.71	37.49	75.97	2.626	162.049	2.588	164.442	176	190	0.93	24.179
405	MALE	REST	8.37	4.03	5.64	192	680.0	18.7551	1.20762	15.53	0.478	6.6	3.94	12.13	0.45	0.94	39.26	41.80	77.55	2.449	19.510	2.415	19.779	79	179	0.44	6.047
405	MALE	150	8.37	4.03	5.64	192	680.0	39.0154	1.72629	22.6007	1.39004	19.3	3.94	35.30	1.04962	0.76	28.07	37.17	77.55	2.449	56.766	2.415	57.548	113	179	0.63	12.301
405	MALE	180	8.37	4.03	5.64	192	680.0	64.3416	2.2577	28.4987	2.47289	34.3	3.94	62.80	1.93258	0.78	26.02	33.29	77.55	2.449	100.987	2.415	102.379	119.5	179	0.67	20.694
405	MALE	210	8.37	4.03	5.64	192	680.0	71.395	2.49585	28.6055	2.65904	36.9	3.94	67.52	2.19942	0.83	26.85	32.46	77.55	2.449	108.589	2.415	110.086	122.5	179	0.68	21.706
405	MALE	240	8.37	4.03	5.64	192	680.0	79.0394	2.69568	29.3207	2.92028	40.6	3.94	74.16	2.52364	0.86	27.07	31.32	77.55	2.449	119.257	2.415	120.902	130	179	0.73	22.464
405	MALE	270	8.37	4.03	5.64	192	680.0	91.3721	2.85681	31.984	3.24603	45.1	3.94	82.43	2.95498	0.91	28.15	30.92	77.55	2.449	132.560	2.415	134.388	137	179	0.77	23.694
405	MALE	300	8.37	4.03	5.64	192	680.0	100.697	2.89653	34.7648	3.4828	48.4	3.94	88.44	3.31763	0.95	28.91	30.35	77.55	2.449	142.230	2.415	144.190	142.5	179	0.80	24.441
405	MALE	Max	8.37	4.03	5.64	192	680.0	116.024	3.08177	37.6486	3.695	51.3	3.94	93.83	3.78679	1.02	31.40	30.64	77.55	2.449	150.895	2.415	152.975	150	179	0.84	24.633

ID	GRP	Stage	$PetCO_2$ IET	PulseOx IET	RPB IET	RPU IET	RPE IET	LEG IET	Blood Lactate IET	Reason IET	Reason Code IET	Peak V_E Mech IET	MinV_t Mech IET	MinV_E Mech IET	V_E/MVV Mech IET	V_t Mech IET	V_t/FVC Mech IET	f_B Mech IET	Avg IC IET	Typ IC IET	EELVavg Mech IET	EELVtyp Mech IET	EELVavg %TLC IET	EELVtyp %TLC IET	EILVavg Mech IET	EILVtyp Mech IET	EILVavg %TLC IET	EILVtyp %TLC IET
400	MALE	REST	.	.	0.5	0	6	0	.	.	.	.	-12.500	12.819	5.432	0.890	#VALUE!	14.473	3.38091	3.292	4.59	4.68	57.580	113.820	188.509	188.598	68.742	69.857
400	MALE	150	41	.	0.5	0	7	0	.	.	.	.	.	.	0.000	.	13.729	.	.	.								
400	MALE	180	42	.	2	2	9	0.5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	210	45	.	0	2	9	2	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	240	44	.	1	1	10	1	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	270	45	.	3	2	11	2	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	300	46	.	4	3	12	2	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	330	42	.	4	3	13	3	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	360	43	.	3	4	11	7	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	390	40	.	3	4	11	7	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	420	37	.		.	.	.	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
400	MALE	450	37	.	7	8	17	5	.	breathing	2	.	-216.953	218.399	92.542	3.869	60.450	56.566	4.84291	4.769	3.13	3.20	39.236	40.163	190.026	190.100	87.778	88.705
402	MALE	REST	.	.	.	.	.	.	.	.	.	.	-15.209	13.946	7.226	.	0.000	16.003	2.32258	.								
402	MALE	150	.	.	4	3	4	2	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	180	.	.	4	3	11	4	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	210	.	.	4	4	12	4	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	240	.	.	4	5	13	4	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	270	.	.	4	5	14	4	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	300	.	.	5	6	15	5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	330	.	.	7	7	15	5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	360	.	.	8	8	17	7	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	390	.	.	.	.	.	.	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
402	MALE	Max	.	.	10	9	19	8	.	LEGS	1	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
	MALE	REST	.	.	.	.	.	.	.	.	.	.	-11.2179	11.855	#DIV/0!	1.305	#DIV/0!	9.383	2.10933	2.533	-2.19	-2.53	#DIV/0!	#DIV/0!	-0.885	-1.228	#DIV/0!	#DIV/0!
403	MALE	150	.	.	0	0	6	0	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
403	MALE	180	.	.	0	0	8	0.5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
403	MALE	210	.	.	0	0	11	2	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
403	MALE	240	.	.	0.5	0	14	5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
403	MALE	Max	.	.	1	0.5	19	7	.	LEGS	1	.	-151.059	150.644	91.856	3.507	66.806	43.128	3.85362	3.895	2.86	2.82	42.569	41.952	172.654	172.612	94.839	94.222
404	MALE	REST	.	.	.	.	.	.	.	.	.	.	-11.980	12.165	4.789	0.783	14.011	15.647	2.6297	2.698	5.01	4.94	65.580	114.398	171.154	171.085	75.831	74.937
404	MALE	150	41	.	0.5	0	6	0	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
404	MALE	180	41	.	0.5	0	7	0	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
404	MALE	210	41	.	0.5	0	7	0	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
404	MALE	240	41	.	1	0	9	0.5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
404	MALE	270	40	.	2	1	9	0.5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
404	MALE	300	38	.	3	2	11	2	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
404	MALE	330	37	.	3	2	11	3	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
404	MALE	360	35	.	5	3	16	3	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
404	MALE	Max	33	.	.	.	.	.	.	LEGS	1	.	-183.354	182.949	72.027	3.334	59.633	54.909	4.30842	4.29	3.33	3.35	43.607	43.848	172.025	172.044	87.239	87.480
405	MALE	REST	.	.	0.5	0	6	0.5	.	.	.	.	-23.176	22.240	11.583	1.222	21.661	18.747	2.8345	2.743	5.54	5.63	66.135	139.628	173.387	173.479	80.731	81.824
405	MALE	150	.	.	0.5	0.5	6	0.5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
405	MALE	180	.	.	2	1	7	1	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
405	MALE	210	.	.	3	3	11	4	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
405	MALE	240	.	.	3	3	11	3	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
405	MALE	270	.	.	3	4	12	3	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
405	MALE	300	.	.	4	4	13	5	.	.	.	.	.	.	#VALUE!	.	#VALUE!	.	.	.	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
405	MALE	Max	.	.	5	5	14	4	.	.	.	.	-153.679	153.638	80.020	3.368	59.710	45.541	3.80329	3.828	4.57	4.54	54.561	54.265	174.564	174.540	94.795	94.500

ID	GRP	Stage	Ti Mech IET	Te Mech IET	Ti/Ttot Mech IET	V_T/Ti Mech IET	V_T/Te Mech IET	$PetCO_2$ Mech IET	expBTPS Mech IET	Max Pi Mech IET	Max Pe Mech IET	Mouth Pressure
400	MALE	REST	1.557	2.642	37.231	#REF!	#REF!	38.0779	1.067	-1.12209	1.20318	-1.08488
400	MALE	150				0.572	0.337	.	.	.	.	
400	MALE	180	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	210	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	240	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	270	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	300	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	330	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	360	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	390	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	420	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
400	MALE	450	0.502	0.560	47.278	7.705	6.909	35.201	1.067	-10.165	13.427	-3.429
402	MALE	REST	1.828	2.041	47.639	0.000	0.000	39.896	1.067	-1.237	1.295	
402	MALE	150	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	180	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	210	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	240	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	270	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	300	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	330	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	360	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	390	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
402	MALE	Max	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
	MALE	REST	2.703	3.889	40.417	0.483	0.335	39.635	1.067	-1.207	1.192	-1.904
403	MALE	150	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
403	MALE	180	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
403	MALE	210	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
403	MALE	240	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
403	MALE	Max	0.676	0.727	48.216	5.192	4.825	30.454	1.067	-7.704	11.714	-3.272
404	MALE	REST	1.416	2.460	36.647	0.553	0.318	39.019	1.067	-1.626	1.718	-0.917
404	MALE	150	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
404	MALE	180	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
404	MALE	210	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
404	MALE	240	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
404	MALE	270	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
404	MALE	300	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
404	MALE	330	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
404	MALE	360	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
404	MALE	Max	0.530	0.564	48.418	6.294	5.906	32.193	1.067	-8.486	13.418	-2.999
405	MALE	REST	1.374	1.924	42.277	0.889	0.635	38.622	1.067	-1.949	2.017	-1.234
405	MALE	150	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
405	MALE	180	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
405	MALE	210	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
405	MALE	240	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
405	MALE	270	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
405	MALE	300	.	.	.	#VALUE!	#VALUE!	.	.	.	.	
405	MALE	Max	0.602	0.723	45.424	5.598	4.661	40.073	1.067	-8.267	9.422	-2.987

ID	GRP	Stage	IETWatts	IETMax Time	AGE	HT (cm)	WT (kg)	TLC	FRC	FVC	MVV	P_B	V_E IET	V_T IET	f_B IET	VO_2 IET	VO_2 ml/kg IET	Peak VO_2 IET	PerVO_2 IET	VCO_2 IET	RER IET	V_E/VO_2 IET	V_E/VCO_2 IET	Pred WT IET	PVO_2 PWT IET	$PPVO_2$ PWT IET	PVO_2+C PWT IET
406	MALE	REST		1	42	192.0	92.9	10.77	5.42	7.46	228	683.0	16.75	1.51	11.06	0.478	5.1	4.96	9.62	0.47	0.98	35.07	35.66	90.98	3.263	14.635	3.275
406	MALE	150	150	2	42	192.0	92.9	10.77	5.42	7.46	228	683.0	49.84	2.17	23.00	1.670	18.0	4.96	33.65	1.46	0.87	29.84	34.11	90.98	3.263	51.183	3.275
406	MALE	180	180	3	42	192.0	92.9	10.77	5.42	7.46	228	683.0	72.93	3.19	22.84	2.747	29.6	4.96	55.35	2.320078	0.84	26.55	31.44	90.98	3.263	84.176	3.275
406	MALE	210	210	4	42	192.0	92.9	10.77	5.42	7.46	228	683.0	79.03	3.08	25.68	2.791	30.0	4.96	56.23	2.52734	0.91	28.32	31.27	90.98	3.263	85.521	3.275
406	MALE	240	240	5	42	192.0	92.9	10.77	5.42	7.46	228	683.0	86.42	3.47	24.93	3.026	32.6	4.96	60.97	2.85508	0.94	28.56	30.27	90.98	3.263	92.730	3.275
406	MALE	270	270	6	42	192.0	92.9	10.77	5.42	7.46	228	683.0	105.35	3.56	29.57	3.598	38.7	4.96	72.50	3.419604	0.95	29.28	30.81	90.98	3.263	110.264	3.275
406	MALE	300	300	7	42	192.0	92.9	10.77	5.42	7.46	228	683.0	122.65	4.05	30.28	3.942	42.4	4.96	79.43	3.930982	1.00	31.11	31.20	90.98	3.263	120.806	3.275
406	MALE	330	330	8	42	192.0	92.9	10.77	5.42	7.46	228	683.0	134.78	4.29	31.41	4.242	45.7	4.96	85.48	4.324545	1.02	31.77	31.17	90.98	3.263	130.000	3.275
406	MALE	360	360	9	42	192.0	92.9	10.77	5.42	7.46	228	683.0	152.34	4.29	35.50	4.499	48.4	4.96	90.65	4.702532	1.05	33.86	32.40	90.98	3.263	137.873	3.275
406	MALE	390	390	10	42	192.0	92.9	10.77	5.42	7.46	228	683.0	176.71	4.20	42.11	4.771	51.4	4.96	96.13	5.184255	1.09	37.04	34.09	90.98	3.263	146.206	3.275
406	MALE	420	420	11	42	192.0	92.9	10.77	5.42	7.46	228	683.0	202.17	4.16	48.56	4.963	53.4	4.96	100.00	5.598852	1.13	40.74	36.11	90.98	3.263	152.086	3.275
411	MALE	Rest	0	0	49	174.5	68.8	8.40	4.89	5.09	198	691.0	21.82	1.29	16.90	0.458	6.7	4.33	10.58	0.42	0.91	47.62	52.10	77.16	2.238	20.477	2.187
411	MALE	150	150	1	49	174.5	68.8	8.4	4.89	5.09	198	691	49.37	1.85	26.64	1.531	22.3	4.33	35.36	1.15	0.75	32.25	42.89	77.16	2.238	68.420	2.187
411	MALE	180	180	2	49	174.5	68.8	8.4	4.89	5.09	198	691	66.60	2.12	31.40	2.352	34.2	4.33	54.31	1.71	0.73	28.32	38.98	77.16	2.238	105.100	2.187
411	MALE	210	210	3	49	174.5	68.8	8.4	4.89	5.09	198	691	72.20	2.51	28.76	2.543	37.0	4.33	58.74	1.971467	0.78	28.39	36.62	77.16	2.238	113.669	2.187
411	MALE	240	240	4	49	174.5	68.8	8.4	4.89	5.09	198	691	80.61	2.71	29.70	2.858	41.5	4.33	65.99	2.323404	0.81	28.21	34.69	77.16	2.238	127.710	2.187
411	MALE	270	270	5	49	174.5	68.8	8.4	4.89	5.09	198	691	90.79	2.82	32.20	3.103	45.1	4.33	71.66	2.677856	0.86	29.26	33.90	77.16	2.238	138.668	2.187
411	MALE	300	300	6	49	174.5	68.8	8.4	4.89	5.09	198	691	110.59	2.81	39.33	3.402	49.5	4.33	78.57	3.139628	0.92	32.50	35.22	77.16	2.238	152.051	2.187
411	MALE	330	330	7	49	174.5	68.8	8.4	4.89	5.09	198	691	130.89	2.97	44.00	3.693	53.7	4.33	85.28	3.627578	0.98	35.45	36.08	77.16	2.238	165.027	2.187
411	MALE	360	360	8	49	174.5	68.8	8.4	4.89	5.09	198	691	157.85	3.00	52.70	3.910	56.8	4.33	90.31	4.130991	1.06	40.37	38.21	77.16	2.238	174.766	2.187
414	MALE	Rest	0	0	46	174.5	67.1	7.23	3.01	4.31	158	686.0	17.30	0.83	20.88	0.292	4.3	3.50	8.33	0.30	1.02	59.32	58.18	77.16	2.257	12.919	2.197
414	MALE	150	150	1	46	174.5	67.1	7.23	3.01	4.31	158	686	33.64	1.04	32.41	1.170	17.4	3.50	33.43	0.78	0.67	28.76	43.07	77.16	2.257	51.836	2.197
414	MALE	180	180	2	46	174.5	67.1	7.23	3.01	4.31	158	686	65.03	1.66	39.12	2.397	35.7	3.50	68.50	1.79	0.75	27.13	36.33	77.16	2.257	106.212	2.197
414	MALE	210	210	3	46	174.5	67.1	7.23	3.01	4.31	158	686	73.99	1.80	41.03	2.496	37.2	3.50	71.32	2.096689	0.84	29.64	35.29	77.16	2.257	110.594	2.197
414	MALE	240	240	4	46	174.5	67.1	7.23	3.01	4.31	158	686	88.01	1.80	48.82	2.800	41.7	3.50	80.00	2.489231	0.89	31.43	35.36	77.16	2.257	124.055	2.197
414	MALE	270	270	5	46	174.5	67.1	7.23	3.01	4.31	158	686	108.71	1.94	55.92	3.089	46.0	3.50	88.25	2.982863	0.97	35.20	36.45	77.16	2.257	136.845	2.197
414	MALE	300	300	6	46	174.5	67.1	7.23	3.01	4.31	158	686	127.77	1.96	65.21	3.365	50.2	3.50	96.15	3.469744	1.03	37.97	36.82	77.16	2.257	149.103	2.197
414	MALE	330	330	7	46	174.5	67.1	7.23	3.01	4.31	158	686	143.66	1.91	75.39	3.461	53.0	3.50	98.87	3.861484	1.12	41.51	37.20	77.16	2.257	153.317	2.197
415	MALE	Rest	0	0	20	186.0	84.7	8.69	4.34	7.47	176	686.0	19.95	1.37	14.53	0.603	7.1	5.36	11.26	0.54	0.90	33.06	36.87	86.24	3.668	16.446	3.659
415	MALE	150	150	1	20	186	84.7	8.69	4.34	7.47	176	686	41.29	2.02	20.48	1.604	18.9	5.36	29.92	1.27	0.79	25.75	32.47	86.24	3.668	43.715	3.659
415	MALE	180	180	2	20	186	84.7	8.69	4.34	7.47	176	686	59.04	2.86	20.66	2.569	30.3	5.36	47.92	2.02	0.79	22.99	29.20	86.24	3.668	70.023	3.659
415	MALE	210	210	3	20	186	84.7	8.69	4.34	7.47	176	686	66.34	3.15	21.09	2.776	32.8	5.36	51.80	2.378956	0.86	23.89	27.89	86.24	3.668	75.682	3.659
415	MALE	240	240	4	20	186	84.7	8.69	4.34	7.47	176	686	75.68	3.10	24.39	3.065	36.2	5.36	57.19	2.724998	0.89	24.69	27.77	86.24	3.668	83.556	3.659
415	MALE	270	270	5	20	186	84.7	8.69	4.34	7.47	176	686	86.08	3.56	24.17	3.466	40.9	5.36	64.67	3.138841	0.91	24.83	27.42	86.24	3.668	94.490	3.659
415	MALE	300	300	6	20	186	84.7	8.69	4.34	7.47	176	686	95.06	3.89	24.44	3.726	44.0	5.36	69.51	3.487101	0.94	25.51	27.26	86.24	3.668	101.567	3.659
415	MALE	330	330	7	20	186	84.7	8.69	4.34	7.47	176	686	108.81	3.93	27.71	4.146	48.9	5.36	77.35	3.997435	0.96	26.24	27.22	86.24	3.668	113.021	3.659
415	MALE	360	360	8	20	186	84.7	8.69	4.34	7.47	176	686	126.10	4.08	30.88	4.438	52.4	5.36	82.81	4.434992	1.00	28.41	28.43	86.24	3.668	120.991	3.659
415	MALE	390	390	9	20	186	84.7	8.69	4.34	7.47	176	686	146.92	3.94	37.29	4.721	55.7	5.36	88.09	4.891449	1.04	31.12	30.04	86.24	3.668	128.707	3.659
415	MALE	420	420	10	20	186	84.7	8.69	4.34	7.47	176	686	172.03	4.12	41.78	5.112	60.4	5.36	95.38	5.538401	1.08	33.65	31.06	86.24	3.668	139.359	3.659
415	MALE	450	450	11	20	186	84.7	8.69	4.34	7.47	176	686	201.37	4.02	50.07	5.281	63.3	5.36	98.52	6.020534	1.14	38.13	33.45	86.24	3.668	143.956	3.659

ID	GRP	Stage	$PPVO_2$+C PWT IET	HR IET	PHR IET	HR PP IET	O2Pul IET	$PetCO_2$ IET	PulseOx IET	RPB IET	RPU IET	RPE IET	LEG IET	Blood Lactate IET	Reason IET	Reason Code IET	Peak V_E Mech IET	$MinV_I$ Mech IET	$MinV_E$ Mech IET	V_E/MVV Mech IET	V_T Mech IET	V_T/FVC Mech IET
406	MALE	REST	14.584	90	182	0.49	5.306		99	0.5	0	6	0					-15.167	14.548	6.381	1.567	20.999
406	MALE	150	51.003	134	182	0.74	12.464		98	0.5	0	6	0							#VALUE!		#VALUE!
406	MALE	180	83.880	137	182	0.75	20.050		98	1	0	7	0							#VALUE!		#VALUE!
406	MALE	210	85.220	139	182	0.76	20.077		98	2	0.5	7	0							#VALUE!		#VALUE!
406	MALE	240	92.403	146	182	0.80	20.726		97	1	0.5	8	0							#VALUE!		#VALUE!
406	MALE	270	109.876	150	182	0.82	23.988		97	2	0.5	9	0							#VALUE!		#VALUE!
406	MALE	300	120.381	159	182	0.87	24.793		97	1	0.5	10	0							#VALUE!		#VALUE!
406	MALE	330	129.543	163	182	0.89	26.026		96	4	1	12	0.5							#VALUE!		#VALUE!
406	MALE	360	137.388	170	182	0.93	26.465		97	5	2	14	1							#VALUE!		#VALUE!
406	MALE	390	145.692	175	182	0.96	27.263		96	5	4	15	2							#VALUE!		#VALUE!
406	MALE	420	151.551	180	182	0.99	27.572		96	9	3	17	2		LEGS	1		-223.245	225.438	98.876	3.514	47.101
411	MALE	Rest	20.946	0	175	0.00	#DIV/0!	34	97									-19.910	20.363	10.284	1.030	20.230
411	MALE	150	69.988	0	175	0.00	#DIV/0!	28	97	0.5	0	8	0							#VALUE!		#VALUE!
411	MALE	180	107.508	0	175	0.00	#DIV/0!	28	95	0.5	0.5	8	0.5							#VALUE!		#VALUE!
411	MALE	210	116.274	0	175	0.00	#DIV/0!	30	95	0.5	0.5	9	0.5							#VALUE!		#VALUE!
411	MALE	240	130.637	127	175	0.73	22.500	38	95	1	1	9	1							#VALUE!		#VALUE!
411	MALE	270	141.846	133	175	0.76	23.417	35	93	2	2	10	3							#VALUE!		#VALUE!
411	MALE	300	155.536	140	175	0.80	24.301	40	93	4	4	15	3							#VALUE!		#VALUE!
411	MALE	330	168.810	147	175	0.84	25.119	34	93	7	6	16	7							#VALUE!		#VALUE!
411	MALE	360	178.772	152	175	0.87	25.726	32	92	8	6	17	7		LEGS	1		-176.202	176.003	88.890	3.001	58.961
414	MALE	Rest	13.273	64	178	0.36	4.556			2	0	6	0					-16.527	17.033	10.780	0.937	21.746
414	MALE	150	53.259	121	178	0.68	9.669			3	0.5	10	0							#VALUE!		#VALUE!
414	MALE	180	109.129	134	178	0.75	17.891			3	1	11	0							#VALUE!		#VALUE!
414	MALE	210	113.632	141	178	0.79	17.704			3	1	12	0.5							#VALUE!		#VALUE!
414	MALE	240	127.462	146	178	0.82	19.179			4	3	12	0.5							#VALUE!		#VALUE!
414	MALE	270	140.603	154	178	0.87	20.057			5	3	13	1							#VALUE!		#VALUE!
414	MALE	300	153.197	160	178	0.90	21.034			7	4	15	3							#VALUE!		#VALUE!
414	MALE	330	157.528	166	178	0.93	20.847			9	9	17	3		3REATHINK	2				#VALUE!		#VALUE!
415	MALE	Rest	16.487	83	206	0.40	7.313	38	97	0.5	0	6	0					-20.403	22.084	12.548	1.716	22.972
415	MALE	150	43.826	117	206	0.57	13.706	42	97	2	0	9	0.5							#VALUE!		#VALUE!
415	MALE	180	70.200	128	206	0.62	20.147	42	97	4	0	11	1							#VALUE!		#VALUE!
415	MALE	210	75.873	134	206	0.65	20.719	42	97	3	0.5	12	0.5							#VALUE!		#VALUE!
415	MALE	240	83.767	142	206	0.69	21.585	42	97	4	1	13	1							#VALUE!		#VALUE!
415	MALE	270	94.728	150	206	0.73	23.185	42	96	4	2	13	2							#VALUE!		#VALUE!
415	MALE	300	101.823	161	206	0.78	23.142	40	95	4	2	14	3							#VALUE!		#VALUE!
415	MALE	330	113.306	166	206	0.80	25.051	40	94	5	3	15	4							#VALUE!		#VALUE!
415	MALE	360	121.297	172	206	0.84	25.805		94	7	3	16	6							#VALUE!		#VALUE!
415	MALE	390	129.032	176	206	0.86	26.826			7	3	18	7							#VALUE!		#VALUE!
415	MALE	420	139.711	181	206	0.88	28.244													#VALUE!		#VALUE!
415	MALE	450	144.320	185	206	0.90	28.545			9	7	19	9		LEGS	2		-211.357	211.698	120.283	3.898	52.187

ID	GRP	Stage	f_B Mech IET	Avg IC IET	Typ IC IET	EELVavg Mech IET	EELVtyp Mech IET	EELVavg %TLC IET	EELVtyp %TLC IET	EILVavg Mech IET	EILVtyp Mech IET	EILVavg %TLC IET	EILVtyp %TLC IET	Ti Mech IET	Te Mech IET	Ti/Ttot Mech IET	V_T/Ti Mech IET	V_T/Te Mech IET	$PetCO_2$ Mech IET	expBTPS Mech IET	Max Pi Mech IET	Max Pe Mech IET	Mouth Pressure
406	MALE	REST	9.434	3.743833	4.034	7.03	6.74	65.238	124.280	189.823	189.533	79.783	77.089	2.375	4.099	36.322	0.660	0.382	34.388	1.067	-1.309	1.156	-1.840
406	MALE	150				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	180				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	210				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	240				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	270				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	300				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	330				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	360				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	390				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
406	MALE	420	64.318	4.508909	4.552	6.26	6.22	58.135	57.734	191.005	190.962	90.760	90.360	0.450	0.486	48.137	7.810	7.235	29.282	1.067	-10.760	15.898	-3.277
411	MALE	Rest	19.928	2.9242	2.872	5.48	5.53	65.188	113.047	172.606	172.658	77.446	78.068	1.346	1.734	43.594	0.765	0.594	30.744	1.066	-1.642	1.676	-1.170
411	MALE	150				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
411	MALE	180				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
411	MALE	210				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
411	MALE	240				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
411	MALE	270				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
411	MALE	300				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
411	MALE	330				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
411	MALE	360	58.656	4.319818	4.338	4.08	4.06	48.574	48.357	173.181	173.163	84.301	84.084	0.463	0.561	45.228	6.484	5.353	31.633	1.066	-9.086	11.081	-2.826
414	MALE	Rest	18.413	2.048625	1.946	5.18	5.28	71.665	175.548	173.389	173.491	84.628	86.048	1.558	1.740	47.186	0.602	0.539	30.476	1.067	-1.487	1.408	-1.080
414	MALE	150				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
414	MALE	180				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
414	MALE	210				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
414	MALE	240				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
414	MALE	270				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
414	MALE	300				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
414	MALE	330				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	Rest	13.306	4.8068	4.897	3.88	3.79	44.686	87.396	182.909	182.819	64.433	63.395	1.704	3.131	35.333	1.007	0.548	38.520		-1.509	1.438	-1.780
415	MALE	150				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	180				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	210				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	240				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	270				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	300				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	330				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	360				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	390				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	420				#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!				#VALUE!	#VALUE!					
415	MALE	450	54.361	5.245545	5.216	3.44	3.47	39.637	39.977	184.653	184.682	84.497	84.837	0.515	0.592	46.638	7.567	6.580	34.377		-10.401	15.547	-3.918

Appendix A.d: Raw Data - Caffeine Time Trial

ID	GRP	Order	Prescribed Work	Work (J)	Work (%)	AGE	HT (cm)	WT (kg)	Sex	TLC	FRC	FVC	MVV	P_B	TT Watts
400	MALE	2	0.0		0.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	.
400	MALE	2	10.0		10.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	387.24
400	MALE	2	20.0		20.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	364.124
400	MALE	2	30.0		30.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	350.33
400	MALE	2	40.0		40.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	342.707
400	MALE	2	50.0		50.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	333.13
400	MALE	2	60.0		60.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	319.648
400	MALE	2	70.0		70.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	319.121
400	MALE	2	80.0		80.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	334.789
400	MALE	2	90.0		90.0	24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	333.164
400	MALE	2	100.0			24	191.0	78.2	M	7.97	4.11	6.40	236	675.0	371.737
402	MALE	2	0.0		0.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	
402	MALE	2	10.0		10.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	237.443
402	MALE	2	20.0		20.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	285.654
402	MALE	2	30.0		30.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	284.147
402	MALE	2	40.0		40.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	281.493
402	MALE	2	50.0		50.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	266.568
402	MALE	2	60.0		60.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	252.881
402	MALE	2	70.0		70.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	243.59
402	MALE	2	80.0		80.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	246.541
402	MALE	2	90.0		90.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	236.252
402	MALE	2	100.0		100.0	19	183.0	70.0	M	7.88	3.94	5.84	193	683.0	265.526
403	MALE	2	0.0		0.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	
403	MALE	2	10.0		10.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	151.658
403	MALE	2	20.0		20.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	161.989
403	MALE	2	30.0		30.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	166.672
403	MALE	2	40.0		40.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	169.975
403	MALE	2	50.0		50.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	167.229
403	MALE	2	60.0		60.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	173.377
403	MALE	2	70.0		70.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	176.68
403	MALE	2	80.0		80.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	182.404
403	MALE	2	90.0		90.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	197.261
403	MALE	2	100.0		100.0	26	173.0	56.8	M	6.71	3.20	5.25	164	680.0	189.528
404	MALE	1	0.0		0.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	
404	MALE	1	10.0		10.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	234.844
404	MALE	1	20.0		20.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	262.277
404	MALE	1	30.0		30.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	272.573
404	MALE	1	40.0		40.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	281.168
404	MALE	1	50.0		50.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	273.274
404	MALE	1	60.0		60.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	272.262
404	MALE	1	70.0		70.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	270.99
404	MALE	1	80.0		80.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	278.132
404	MALE	1	90.0		90.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	285.447
404	MALE	1	100.0		100.0	35	173.0	69.6	M	7.64	4.32	5.59	254	680.0	312.174

ID	GRP	Order	Prescribed Work	V_E TT	V_E/MVV TT	V_T TT	f_B TT	VO_2 TT	VO_2 ml/kg TT	Peak VO_2 TT	Peak VO_2 IET	Peak VO_2 IET	PerVO_2 TT	VCO_2 TT	RER TT	V_E/VO_2 TT	V_E/VCO_2 TT	HR TT	PHR TT	HR PP TT	O2Pul TT	PetCO_2 TT
400	MALE	2	0.0	6.54	2.77	0.31	22.17	0.19	2.4	5.05	5.21	66.63	3.77	0.19	0.99	34.39	34.80	69	177	38.98	2.757	41
400	MALE	2	10.0	165.11	69.96	3.70	44.76	4.83	61.8	5.05	5.21	66.63	95.78	5.47	1.13	34.16	30.20	162	177	91.53	29.839	37
400	MALE	2	20.0	163.22	69.16	3.25	50.21	4.893	62.6	5.05	5.21	66.63	96.94	4.93987	1.01	33.36	33.04	164	177	92.87	29.766	34
400	MALE	2	30.0	175.85	74.51	3.34	52.66	4.872	62.3	5.05	5.21	66.63	96.53	4.83115	0.99	36.10	36.40	166	177	93.93	29.304	34
400	MALE	2	40.0	159.12	67.43	3.11	51.17	4.691	60.0	5.05	5.21	66.63	92.94	4.44788	0.95	33.92	35.78	166	177	94.00	28.193	34
400	MALE	2	50.0	156.08	66.14	3.12	50.30	4.591	58.7	5.05	5.21	66.63	90.97	4.31904	0.94	34.00	36.14	168	177	95.06	27.288	34
400	MALE	2	60.0	152.91	64.79	2.89	52.79	4.672	59.7	5.05	5.21	66.63	92.57	4.26953	0.91	32.73	35.82	167	177	94.42	27.956	34
400	MALE	2	70.0	152.74	64.72	2.87	53.35	4.467	57.1	5.05	5.21	66.63	88.51	4.13982	0.93	34.19	36.90	168	177	94.92	26.590	34
400	MALE	2	80.0	159.56	67.61	2.97	53.72	4.576	58.5	5.05	5.21	66.63	90.67	4.31116	0.94	34.87	37.01	171	177	96.75	26.723	31
400	MALE	2	90.0	170.37	72.19	3.05	55.85	4.623	59.1	5.05	5.21	66.63	91.60	4.42463	0.96	36.85	38.50	175	177	98.73	26.455	33
400	MALE	2	100.0	211.48	89.61	3.04	69.54	5.047	64.5	5.05	5.21	66.63	100.01	5.06448	1.00	41.90	41.76	176	177	99.58	28.637	28
402	MALE	2	0.0	17.23	8.93	1.44	13.12	0.40	5.7	3.75	4.52	64.65	10.72	0.43	1.06	42.86	40.35	77	186	41.47	5.211	34
402	MALE	2	10.0	109.80	56.89	2.56	43.06	3.66	52.3	3.75	4.52	64.65	97.58	3.42	0.93	30.02	32.14	153	186	82.06	23.968	41
402	MALE	2	20.0	133.00	68.91	2.79	47.42	3.528	50.4	3.75	4.52	64.65	94.10	3.74239	1.06	37.70	35.54	175	186	93.82	20.216	36
402	MALE	2	30.0	126.43	65.51	2.72	46.48	3.554	50.8	3.75	4.52	64.65	94.81	3.55838	1.00	35.57	35.53	177	186	95.30	20.054	34
402	MALE	2	40.0	138.81	71.92	2.69	51.92	3.914	55.9	3.75	4.52	64.65	104.41	3.7977	0.97	35.46	36.55	180	186	96.98	21.700	33
402	MALE	2	50.0	134.49	69.68	2.54	52.97	3.579	51.1	3.75	4.52	64.65	95.47	3.46392	0.97	37.58	38.83	180	186	96.77	19.884	36
402	MALE	2	60.0	111.13	57.58	2.37	46.98	3.213	45.9	3.75	4.52	64.65	85.70	2.92843	0.91	34.59	37.95	177	186	95.30	18.126	30
402	MALE	2	70.0	132.40	68.60	2.36	56.16	3.426	48.9	3.75	4.52	64.65	91.39	3.18157	0.93	38.64	41.62	176	186	94.62	19.467	32
402	MALE	2	80.0	130.32	67.53	2.59	50.30	3.321	47.4	3.75	4.52	64.65	88.59	3.13967	0.95	39.24	41.51	178	186	95.63	18.670	32
402	MALE	2	90.0	131.44	68.11	2.26	58.34	3.389	48.4	3.75	4.52	64.65	90.39	3.13433	0.92	38.79	41.94	178	186	95.43	19.091	29
402	MALE	2	100.0	152.53	79.03	2.62	58.27	3.695	52.8	3.75	4.52	64.65	98.57	3.66011	0.99	41.28	41.67	185	186	99.19	20.028	33
403	MALE	2	0.0	13.53	8.25	0.99	14.04	0.47	8.3	3.19	3.12	54.90	14.70	0.46	0.99	28.84	29.24	99	176	56.25	4.738	.
403	MALE	2	10.0	66.58	40.60	3.51	18.99	2.23	39.3	3.19	3.12	54.90	69.96	2.27	1.02	29.83	29.29	152	176	86.29	14.694	.
403	MALE	2	20.0	63.35	38.63	3.57	17.87	2.474	43.6	3.19	3.12	54.90	77.55	2.42164	0.98	25.60	26.16	166	176	94.18	14.926	.
403	MALE	2	30.0	61.23	37.33	3.52	17.46	2.489	43.8	3.19	3.12	54.90	78.03	2.37028	0.95	24.60	25.83	166	176	94.39	14.984	.
403	MALE	2	40.0	71.26	43.45	3.71	19.23	2.798	49.3	3.19	3.12	54.90	87.71	2.74098	0.98	25.47	26.00	167	176	94.74	16.779	.
403	MALE	2	50.0	64.12	39.10	3.34	19.25	2.388	42.0	3.19	3.12	54.90	74.87	2.41804	1.01	26.85	26.52	167	176	94.96	14.290	.
403	MALE	2	60.0	69.30	42.26	2.97	23.34	2.535	44.6	3.19	3.12	54.90	79.47	2.53768	1.00	27.34	27.31	170	176	96.59	14.913	.
403	MALE	2	70.0	80.61	49.15	3.20	25.21	2.643	46.5	3.19	3.12	54.90	82.85	2.71946	1.03	30.50	29.64	173	176	98.44	15.256	.
403	MALE	2	80.0	84.28	51.39	2.75	30.74	2.887	50.8	3.19	3.12	54.90	90.52	2.881	1.00	29.19	29.25	176	176	99.86	16.429	.
403	MALE	2	90.0	87.54	53.38	2.45	35.55	2.746	48.4	3.19	3.12	54.90	86.10	2.79832	1.02	31.87	31.28	179	176	101.42	15.386	.
403	MALE	2	100.0	90.52	55.20	2.41	37.80	2.902	51.1	3.19	3.12	54.90	90.97	2.86833	0.99	31.19	31.56	176	176	99.86	16.512	.
404	MALE	1	0.0	12.27	4.83	0.64	19.28	0.36	5.1	4.66	4.36	61.82	7.62	0.30	0.86	34.54	40.27	56	177	31.64	6.342	39
404	MALE	1	10.0	99.12	39.02	2.68	37.02	3.22	46.3	4.66	4.36	61.82	69.12	2.93	0.91	30.77	33.88	143	177	80.65	22.564	37
404	MALE	1	20.0	106.08	41.76	2.69	39.54	3.265	46.9	4.66	4.36	61.82	70.06	3.04808	0.93	32.49	34.80	152	177	86.02	21.442	37
404	MALE	1	30.0	113.66	44.75	2.79	40.71	3.576	51.4	4.66	4.36	61.82	76.74	3.30431	0.92	31.78	34.40	158	177	89.19	22.652	36
404	MALE	1	40.0	128.70	50.67	2.88	44.81	3.671	52.7	4.66	4.36	61.82	78.78	3.4972	0.95	35.05	36.80	162	177	91.53	22.663	33
404	MALE	1	50.0	129.42	50.95	2.85	45.35	3.681	52.9	4.66	4.36	61.82	78.98	3.43188	0.93	35.16	37.71	162	177	91.34	22.767	33
404	MALE	1	60.0	128.05	50.41	2.88	44.51	3.790	54.4	4.66	4.36	61.82	81.32	3.49227	0.92	33.79	36.67	163	177	92.02	23.267	32
404	MALE	1	70.0	133.79	52.67	2.91	46.05	3.992	57.4	4.66	4.36	61.82	85.66	3.63741	0.91	33.51	36.78	164	177	92.80	24.304	35
404	MALE	1	80.0	138.56	54.55	2.90	47.74	3.797	54.6	4.66	4.36	61.82	81.48	3.58194	0.94	36.49	38.68	168	177	94.70	22.653	33
404	MALE	1	90.0	143.82	56.62	2.92	49.17	3.898	56.0	4.66	4.36	61.82	83.66	3.6615	0.94	36.89	39.28	168	177	95.06	23.170	30
404	MALE	1	100.0	170.90	67.28	3.03	56.30	4.235	60.8	4.66	4.36	61.82	90.88	4.18815	0.99	40.35	40.81	176	177	99.58	24.029	32

ID	GRP	Order	Prescribed Work	PulseOx TT	HR Mech TT	RPE TT	RPB TT	RPU TT	LEG PAIN	Blood Lactate TT	Reason TT	Reason Code CPX	Peak V_E Mech TT	MinVI Mech TT	MinVE Mech TT	VE/MVV Mech TT	VT Mech TT	VT/FVC Mech TT	fB Mech TT	Avg IC TT	Typ IC TT
400	MALE	2	0.0	97	69	6	0	0	0	1	.	.	.	-18.268	18.575	7.871	1.343	20.989	13.776	3.4973	3.379
400	MALE	2	10.0	90	154	11	2	2	2	.	.	.	.	-175.341	172.934	73.277	3.686	57.592	47.063	4.73573	4.972
400	MALE	2	20.0	92	159	14	4	4	2	.	.	.	.	-169.940	169.180	71.686	3.217	50.264	52.649	4.2665	4.277
400	MALE	2	30.0	.	.	15	5	4	3	.	.	.	.	-173.938	174.429	73.911	3.294	51.462	52.989	4.432	4.502
400	MALE	2	40.0	.	.	16	5	4	4	.	.	.	.	-165.790	164.390	69.657	3.184	49.745	51.670	4.2155	4.176
400	MALE	2	50.0	88	164	17	7	7	6	8.4	.	.	.	-158.890	159.810	67.716	3.312	51.750	48.464	4.3531	4.372
400	MALE	2	60.0	.	.	16	8	7	5	.	.	.	.	-156.990	157.120	66.576	3.003	46.925	52.433	4.107	4.102
400	MALE	2	70.0	.	.	17	7	7	6	.	.	.	.	-155.250	154.800	65.593	2.912	45.504	53.223	4.13518	4.187
400	MALE	2	80.0	90	168	18	8	7	7	.	.	.	.	-167.510	167.940	71.161	3.022	47.219	55.639	4.1728	4.204
400	MALE	2	90.0	.	.	18	8	8	8	.	.	.	.	-173.040	173.680	73.593	3.129	48.889	55.618	3.9364	3.856
400	MALE	2	100.0	90	173	20	10	10	9	10	.	.	.	-212.680	212.330	89.970	2.956	46.188	71.852	4.0735	4.161
402	MALE	2	0.0	.	.	6	1	1	2	1.1	.	.	.	-19.014	21.700	11.244	1.235	21.143	17.329	2.72813	2.898
402	MALE	2	10.0	.	.	12	4	3	3	.	.	.	.	-122.660	111.941	58.000	2.484	42.540	45.029	3.92955	3.794
402	MALE	2	20.0	.	.	14	4	4	4	.	.	.	.	-147.056	148.262	76.820	3.118	53.398	47.688	3.99583	3.906
402	MALE	2	30.0	.	.	14	5	5	5	.	.	.	.	-143.322	143.478	74.341	2.731	46.761	52.880	3.80677	3.694
402	MALE	2	40.0	.	.	16	7	7	6	.	.	.	.	-149.867	149.604	77.515	2.827	48.400	53.243	3.85291	3.82
402	MALE	2	50.0	.	.	16	7	8	7	7.1	.	.	.	-152.010	152.826	79.184	2.545	43.582	60.313	3.6639	3.708
402	MALE	2	60.0	.	.	17	8	7	8	.	.	.	.	-156.570	157.850	81.788	2.800	47.937	56.464	3.525	3.525
402	MALE	2	70.0	.	.	16	7	8	7	.	.	.	.	-128.688	130.194	67.458	2.180	37.323	59.785	3.78809	3.788
402	MALE	2	80.0	.	.	17	7	8	7	.	.	.	.	-138.159	138.124	71.567	2.374	40.646	58.450	3.37483	3.447
402	MALE	2	90.0	.	.	17	7	9	8	.	.	.	.	-135.555	135.621	70.270	2.295	39.296	59.769	3.53631	3.427
402	MALE	2	100.0	.	.	18	7	10	8	7.5	.	.	.	-162.962	164.067	85.009	2.637	45.151	65.571	3.72558	3.698
403	MALE	2	0.0	.	.	6	0	0	0	1.3	.	.	.	-12.770	12.667	7.724	1.400	26.657	9.078	3.18213	3.209
403	MALE	2	10.0	.	.	10	0	0	1	.	.	.	.	-69.470	69.076	42.119	3.608	68.722	19.154	4.16933	4.167
403	MALE	2	20.0	.	.	11	0.5	0	3	.	.	.	.	-67.043	67.802	41.343	3.741	71.249	18.257	4.15242	3.945
403	MALE	2	30.0	.	.	12	1	0	2	.	.	.	.	-65.012	65.425	39.893	3.362	64.033	19.464	3.77425	3.854
403	MALE	2	40.0	.	.	11	1	0	2	.	.	.	.	-71.366	72.1155	43.973	3.749	71.418	19.2618	4.12036	4.005
403	MALE	2	50.0	.	.	12	3	0	3	8.7	.	.	.	-71.020	71.6972	43.718	3.391	64.590	21.202	3.93482	3.949
403	MALE	2	60.0	.	.	12	1	0	4	.	.	.	.	-73.891	73.917	45.071	3.176	60.489	23.308	3.53275	3.55
403	MALE	2	70.0	.	.	13	1	0	4	.	.	.	.	-84.635	86.250	52.591	3.143	59.860	27.624	3.30745	3.37
403	MALE	2	80.0	.	.	14	1	0.5	5	.	.	.	.	-89.641	89.265	54.430	2.842	54.130	31.397	3.32133	3.347
403	MALE	2	90.0	.	.	15	3	1	5	.	.	.	.	-97.265	97.483	59.441	2.773	52.811	35.333	3.19542	3.085
403	MALE	2	100.0	.	.	16	3	1	5	10.9	.	.	.	-100.906	100.298	61.157	2.428	46.254	41.417	3.33658	3.393
404	MALE	1	0.0	.	.	6	0	0	0	1.1	.	.	.	-14.647	15.002	5.906	0.926	16.562	16.265	2.7166	2.649
404	MALE	1	10.0	.	.	7	0.5	0.5	0.5	.	.	.	.	-100.670	100.820	39.693	2.758	49.335	36.548	3.5343	3.59
404	MALE	1	20.0	.	.	7	1	1	1	.	.	.	.	-111.280	110.940	43.677	2.792	49.945	39.780	3.4953	3.465
404	MALE	1	30.0	.	.	9	1	1	1	.	.	.	.	-131.030	130.750	51.476	2.888	51.655	45.491	3.6466	3.536
404	MALE	1	40.0	.	.	9	2	1	2	.	.	.	.	-130.220	130.400	51.339	2.987	53.442	43.765	3.5488	3.4
404	MALE	1	50.0	.	.	9	2	3	2	5.5	.	.	.	-135.910	135.970	53.531	2.976	53.234	45.711	3.4923	3.498
404	MALE	1	60.0	.	.	10	3	2	3	.	.	.	.	-140.430	140.510	55.319	2.970	53.131	47.304	3.5772	3.644
404	MALE	1	70.0	.	.	10	4	3	3	.	.	.	.	-137.516	137.477	54.125	2.988	53.459	45.975	3.53691	3.497
404	MALE	1	80.0	.	.	13	4	4	3	.	.	.	.	-146.450	145.690	57.358	3.008	53.816	48.403	3.591	3.606
404	MALE	1	90.0	.	.	13	5	4	4	.	.	.	.	-151.370	152.480	60.031	3.060	54.748	49.798	3.3413	3.461
404	MALE	1	100.0	.	.	15	7	4	6	10.8	.	.	.	-183.040	182.460	71.835	3.143	56.224	58.045	3.722	3.79

ID	GRP	Order	Prescribed Work	EELVavg Mech TT	EELVtyp Mech TT	EELVavg %TLC TT	EELVtyp %TLC TT	EILVavg Mech TT	EILVtyp Mech TT	EILVavg %TLC TT	EILVtyp %TLC TT	Ti Mech TT	Te Mech TT	Ti/Ttot Mech TT	VT/Ti Mech TT	VT/Te Mech TT	PetCO2 Mech TT	expBTPS Mech TT	Max Pi Mech TT	Max Pe Mech TT	Int MP	Processing
400	MALE	2	0.0	4.47	4.59	56.119	111.703	5.816	5.934	72.974	74.458	1.672	2.763	37.591	0.803	0.486	42.800	1.067	-1.241	1.127	-1.335	EML
400	MALE	2	10.0	3.23	3.00	40.581	37.616	6.920	6.684	86.828	83.863	0.608	0.674	47.432	6.062	5.468	38.436	1.067	-6.757	10.553	-2.998	EML
400	MALE	2	20.0	3.70	3.69	46.468	46.336	6.920	6.910	86.831	86.699	0.541	0.601	47.360	5.946	5.352	35.380	1.067	-6.264	9.454	-2.566	EML
400	MALE	2	30.0	3.54	3.47	44.391	43.513	6.832	6.762	85.716	84.838	0.522	0.612	46.020	6.315	5.386	33.190	1.067	-6.747	9.975	-2.655	EML
400	MALE	2	40.0	3.75	3.79	47.108	47.604	6.938	6.978	87.054	87.550	0.531	0.631	45.733	5.994	5.048	33.348	1.067	-6.366	8.929	-2.554	EML
400	MALE	2	50.0	3.62	3.60	45.381	45.144	6.929	6.910	86.937	86.700	0.570	0.677	45.766	5.809	4.891	34.489	1.067	-6.035	9.061	-2.566	EML
400	MALE	2	60.0	3.86	3.87	48.469	48.532	6.866	6.871	86.151	86.213	0.537	0.611	46.741	5.593	4.914	33.613	1.067	-5.772	8.847	-2.318	EML
400	MALE	2	70.0	3.83	3.78	48.116	47.465	6.747	6.695	84.656	84.006	0.533	0.597	47.164	5.464	4.874	33.269	1.067	-5.526	8.054	-2.220	EML
400	MALE	2	80.0	3.80	3.77	47.644	47.252	6.819	6.788	85.561	85.169	0.512	0.569	47.359	5.905	5.309	31.629	1.067	-6.164	9.320	-2.353	EML
400	MALE	2	90.0	4.03	4.11	50.610	51.619	7.163	7.243	89.868	90.877	0.515	0.567	47.550	6.076	5.521	31.699	1.067	-6.966	9.365	-2.478	EML
400	MALE	2	100.0	3.90	3.81	48.890	47.792	6.853	6.765	85.979	84.881	0.403	0.434	48.125	7.343	6.818	28.326	1.067	-9.724	13.720	-2.561	EML
402	MALE	2	0.0	5.15	4.98	65.379	126.447	6.387	6.217	81.048	78.893	1.668	2.023	45.968	0.740	0.611	35.404	1.067	-1.437	1.693	-1.366	EML
402	MALE	2	10.0	3.95	4.09	50.133	51.853	6.435	6.570	81.660	83.380	0.640	0.699	47.761	3.882	3.552	38.114	1.067	-4.160	6.145	-1.929	EML
402	MALE	2	20.0	3.88	3.97	49.291	50.431	7.003	7.092	88.865	90.005	0.644	0.626	50.615	4.843	4.980	35.526	1.067	-5.365	9.774	-2.447	EML
402	MALE	2	30.0	4.07	4.19	51.691	53.122	6.804	6.917	86.346	87.777	1.150	0.571	49.552	2.374	4.780	34.276	1.067	-5.303	8.641	-2.143	EML
402	MALE	2	40.0	4.03	4.06	51.105	51.523	6.854	6.887	86.975	87.393	0.553	0.585	48.594	5.111	4.835	32.186	1.067	-5.670	9.025	-2.252	EML
402	MALE	2	50.0	4.22	4.17	53.504	52.944	6.761	6.717	85.803	85.243	0.477	0.530	47.633	5.331	4.798	31.238	1.067	-5.786	9.657	-2.041	EML
402	MALE	2	60.0	4.36	4.36	55.266	55.266	7.155	7.155	90.793	90.793	0.528	0.540	49.425	5.298	5.180	31.625	1.067	-5.824	10.504	-2.221	EML
402	MALE	2	70.0	4.09	4.09	51.928	51.929	6.272	6.272	79.588	79.589	0.487	0.534	47.195	4.479	4.082	30.642	1.067	-5.253	7.233	-1.697	EML
402	MALE	2	80.0	4.51	4.43	57.172	56.256	6.879	6.807	87.295	86.379	0.497	0.535	48.151	4.773	4.434	29.966	1.067	-4.982	7.599	-1.843	EML
402	MALE	2	90.0	4.34	4.45	55.123	56.510	6.639	6.748	84.246	85.633	0.472	0.543	46.416	4.864	4.224	29.094	1.067	-5.319	7.410	-1.820	EML
402	MALE	2	100.0	4.15	4.18	52.721	53.071	6.791	6.819	86.183	86.533	0.456	0.510	47.184	5.783	5.170	28.303	1.067	-6.439	9.675	-2.152	EML
403	MALE	2	0.0	3.53	3.50	52.576	109.406	4.927	4.901	73.433	73.033	3.219	3.454	48.124	0.435	0.405	39.290	1.067	-1.716	1.802	-2.019	EML
403	MALE	2	10.0	2.54	2.54	37.864	37.899	6.149	6.151	91.633	91.668	1.397	1.745	44.495	2.582	2.068	40.974	1.067	-3.551	4.725	-2.879	EML
403	MALE	2	20.0	2.56	2.77	38.116	41.207	6.298	6.506	93.862	96.954	1.569	1.777	47.065	2.384	2.105	43.941	1.067	-4.193	5.303	-2.996	EML
403	MALE	2	30.0	2.94	2.86	43.752	42.563	6.298	6.218	93.852	92.664	1.501	1.590	48.543	2.239	2.114	44.318	1.067	-3.992	5.426	-2.732	EML
403	MALE	2	40.0	2.59	2.71	38.594	40.313	6.339	6.454	94.472	96.192	1.354	1.778	43.276	2.769	2.109	44.825	1.067	-4.310	5.083	-2.991	EML
403	MALE	2	50.0	2.78	2.76	41.359	41.148	6.166	6.152	91.895	91.684	1.449	1.409	50.577	2.340	2.406	43.576	1.067	-4.145	5.739	-2.743	EML
403	MALE	2	60.0	3.18	3.16	47.351	47.094	6.353	6.336	94.678	94.421	1.254	1.334	48.396	2.532	2.381	42.718	1.067	-4.155	5.504	-2.595	EML
403	MALE	2	70.0	3.40	3.34	50.709	49.776	6.545	6.483	97.544	96.612	1.071	1.130	48.508	2.935	2.781	39.181	1.067	-4.624	6.651	-2.517	EML
403	MALE	2	80.0	3.39	3.36	50.502	50.119	6.231	6.205	92.854	92.471	0.963	0.967	49.881	2.951	2.938	37.867	1.067	-4.687	7.214	-2.337	EML
403	MALE	2	90.0	3.51	3.63	52.378	54.024	6.287	6.398	93.698	95.344	0.856	0.857	50.000	3.239	3.235	36.400	1.067	-4.884	8.122	-2.253	EML
403	MALE	2	100.0	3.37	3.32	50.275	49.434	5.802	5.745	86.464	85.623	0.681	0.777	46.835	3.566	3.125	35.308	1.067	-4.589	6.977	-1.974	EML
404	MALE	1	0.0	4.92	4.99	64.442	115.532	5.849	5.917	76.560	77.445	3.803	1.224	2.580	0.243	0.756	38.291	1.067	-1.808	1.633	-0.978	EML
404	MALE	1	10.0	4.11	4.05	53.740	53.010	6.864	6.808	89.836	89.107	1.649	0.751	0.899	1.672	3.675	37.203	1.067	-4.713	5.411	-2.206	EML
404	MALE	1	20.0	4.14	4.18	54.250	54.647	6.937	6.967	90.793	91.190	1.521	0.698	0.823	1.835	3.999	36.386	1.067	-5.153	6.073	-2.260	EML
404	MALE	1	30.0	3.99	4.10	52.270	53.717	6.881	6.992	90.064	91.512	1.325	0.609	0.716	2.180	4.739	34.592	1.067	-5.688	7.767	-2.375	EML
404	MALE	1	40.0	4.09	4.24	53.550	55.497	7.079	7.227	92.652	94.599	1.383	0.666	0.718	2.159	4.487	34.314	1.067	-5.829	7.848	-2.425	EML
404	MALE	1	50.0	4.15	4.14	54.289	54.215	7.124	7.118	93.240	93.165	1.318	0.616	0.702	2.258	4.830	33.010	1.067	-5.961	7.943	-2.434	EML
404	MALE	1	60.0	4.06	4.00	53.178	52.304	7.033	6.966	92.052	91.178	1.273	0.597	0.676	2.333	4.974	32.318	1.067	-6.034	8.417	-2.452	EML
404	MALE	1	70.0	4.10	4.14	53.705	54.228	7.091	7.131	92.820	93.342	1.314	0.609	0.705	2.275	4.911	32.849	1.067	-6.311	8.404	-2.471	EML
404	MALE	1	80.0	4.05	4.03	52.997	52.801	7.057	7.042	92.373	92.177	1.247	0.600	0.647	2.412	5.014	31.887	1.067	-6.481	9.185	-2.523	EML
404	MALE	1	90.0	4.30	4.18	56.266	54.699	7.359	7.239	96.323	94.757	0.591	0.621	48.568	5.180	4.929	30.991	1.067	-6.852	9.920	-2.544	EML
404	MALE	1	100.0	3.92	3.85	51.283	50.393	7.061	6.993	92.420	91.530	1.037	0.496	0.541	3.031	6.340	29.458	1.067	-8.933	11.153	-2.783	EML

ID	GRP	Order	Prescribed Work	Work (J)	Work (%)	AGE	HT (cm)	WT (kg)	Sex	TLC	FRC	FVC	MVV	P_B	TT Watts
405	MALE	1	0.0		0.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	
405	MALE	1	10.0		10.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	226.819
405	MALE	1	20.0		20.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	259.33
405	MALE	1	30.0		30.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	261.191
405	MALE	1	40.0		40.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	258.888
405	MALE	1	50.0		50.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	256.99
405	MALE	1	60.0		60.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	255.184
405	MALE	1	70.0		70.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	259.451
405	MALE	1	80.0		80.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	259.175
405	MALE	1	90.0		90.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	259.798
405	MALE	1	100.0		100.0	45	175.0	72.0	M	8.37	4.03	5.64	192	687.0	286.745
406	MALE	2	0.0		0.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	
406	MALE	2	10.0		10.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	220.752
406	MALE	2	20.0		20.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	229.358
406	MALE	2	30.0		30.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	235.678
406	MALE	2	40.0		40.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	252.92
406	MALE	2	50.0		50.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	266.634
406	MALE	2	60.0		60.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	262.56
406	MALE	2	70.0		70.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	259.614
406	MALE	2	80.0		80.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	261.609
406	MALE	2	90.0		90.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	260.578
406	MALE	2	100.0		100.0	42	192.0	92.9	M	10.77	5.42	7.46	228	674.0	384.303
411	MALE	1	0.0		0.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	.
411	MALE	1	10.0		10.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	238.541
411	MALE	1	20.0		20.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	257.352
411	MALE	1	30.0		30.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	263.904
411	MALE	1	40.0		40.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	266.228
411	MALE	1	50.0		50.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	262.445
411	MALE	1	60.0		60.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	261.589
411	MALE	1	70.0		70.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	259.77
411	MALE	1	80.0		80.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	256.821
411	MALE	1	90.0		90.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	254.02
411	MALE	1	100.0		100.0	49	174.5	68.8	M	8.40	4.89	5.09	198	683.0	255.454
414	MALE	1	0.0		0.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	0
414	MALE	1	10.0		10.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	183.26
414	MALE	1	20.0		20.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	215.35
414	MALE	1	30.0		30.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	213.367
414	MALE	1	40.0		40.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	212.499
414	MALE	1	50.0		50.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	208.813
414	MALE	1	60.0		60.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	207.54
414	MALE	1	70.0		70.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	208.758
414	MALE	1	80.0		80.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	213.535
414	MALE	1	90.0		90.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	211.893
414	MALE	1	100.0		100.0	46	174.5	66.3	M	7.23	3.01	4.31	158	681.0	214.647
415	MALE	1	0.0		0.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	.
415	MALE	1	10.0		10.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	322.348
415	MALE	1	20.0		20.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	331.497
415	MALE	1	30.0		30.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	338.76
415	MALE	1	40.0		40.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	328.592
415	MALE	1	50.0		50.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	323.674
415	MALE	1	60.0		60.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	325.672
415	MALE	1	70.0		70.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	313.983
415	MALE	1	80.0		80.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	306.2
415	MALE	1	90.0		90.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	311.784
415	MALE	1	100.0		100.0	20	186.0	81.9	M	8.69	4.34	7.47	176	680.0	326.057

ID	GRP	Order	Prescribed Work	V_E TT	V_E/MVV TT	V_T TT	f_B TT	VO_2 TT	VO_2 ml/kg TT	Peak VO_2 TT	Peak VO_2 IET	Peak VO_2 IET	PerVO_2 TT	VCO_2 TT	RER TT	V_E/VO_2 TT	V_E/VCO_2 TT	HR TT	PHR TT	HR PP TT	O2Pul TT	PetCO_2 TT
405	MALE	1	0.0	13.6511	7.11	0.714	19.41	0.336	4.7	3.94	4.06	70.61	8.53	0.35	1.04	40.63	38.97	86	179	48.04	3.907	39
405	MALE	1	10.0	125.303	65.26	3.25522	38.5015	3.81006	52.9	3.94	4.06	70.61	96.70	3.937681258	1.03	32.89	31.82	142.25	179	79.47	26.784	40
405	MALE	1	20.0	137.85	71.80	3.42905	40.2888	4.15307	57.7	3.94	4.06	70.61	105.41	4.381233394	1.05	33.19	31.46	154.5	179	86.31	26.881	38
405	MALE	1	30.0	142.031	73.97	3.37188	42.2179	4.14948	57.6	3.94	4.06	70.61	105.32	4.122768104	0.99	34.23	34.45	162.625	179	90.85	25.516	36
405	MALE	1	40.0	146.157	76.12	3.30519	44.3092	4.15936	57.8	3.94	4.06	70.61	105.57	4.064417541	0.98	35.14	35.96	166.875	179	93.23	24.925	35
405	MALE	1	50.0	143.545	74.76	3.17779	45.2279	4.10244	57.0	3.94	4.06	70.61	104.12	3.95225054	0.96	34.99	36.32	169.125	179	94.48	24.257	33
405	MALE	1	60.0	143.345	74.66	3.16771	45.2627	3.95002	54.9	3.94	4.06	70.61	100.25	3.724132419	0.94	36.29	38.49	170.625	179	95.32	23.150	35
405	MALE	1	70.0	136.85	71.28	3.05536	44.9948	3.91337	54.4	3.94	4.06	70.61	99.32	3.623325109	0.93	34.97	37.77	171.25	179	95.67	22.852	32
405	MALE	1	80.0	142.719	74.33	3.00252	47.875	4.06954	56.5	3.94	4.06	70.61	103.29	3.743953943	0.92	35.07	38.12	172.125	179	96.16	23.643	33
405	MALE	1	90.0	144.836	75.44	3.00399	48.2046	3.88238	53.9	3.94	4.06	70.61	98.54	3.617710412	0.93	37.31	40.04	174.875	179	97.70	22.201	33
405	MALE	1	100.0	150.76	78.52	3.04	49.72	3.967	55.1	3.94	4.06	70.61	100.69	3.940047	0.99	38.00	38.26	179.375	179	100.21	22.116	.
406	MALE	2	0.0	13.13	5.76	1.84	7.24	0.44	4.7	4.88	5.03	54.18	8.99	0.39	0.90	29.94	33.44	71	178	39.89	6.179	34
406	MALE	2	10.0	100.54	44.10	4.10	24.55	3.60	38.8	4.88	5.03	54.18	73.82	3.37	0.94	27.91	29.81	138	178	77.53	26.103	40
406	MALE	2	20.0	89.82	39.40	3.51	26.65	3.154	34.0	4.88	5.03	54.18	64.63	2.951989651	0.94	28.48	30.43	146	178	82.02	21.603	40
406	MALE	2	30.0	99.44	43.61	4.02	24.75	3.334	35.9	4.88	5.03	54.18	68.32	3.188162406	0.96	29.83	31.19	154	178	86.33	21.695	38
406	MALE	2	40.0	114.08	50.03	3.77	30.26	3.665	39.5	4.88	5.03	54.18	75.11	3.501788199	0.96	31.12	32.58	154	178	86.66	23.763	43
406	MALE	2	50.0	133.48	58.54	3.84	34.76	3.979	42.8	4.88	5.03	54.18	81.53	3.880926788	0.98	33.55	34.39		178	0.00	41.322	36
406	MALE	2	60.0	123.53	54.18	3.92	31.52	3.843	41.4	4.88	5.03	54.18	78.76	3.638510227	0.95	32.14	33.95		178	0.00	33.368	36
406	MALE	2	70.0	109.91	48.21	3.91	28.05	3.450	37.1	4.88	5.03	54.18	70.69	3.241072297	0.94	31.86	33.91		178	0.00	32.685	36
406	MALE	2	80.0	128.93	56.55	4.08	31.58	3.885	41.8	4.88	5.03	54.18	79.60	3.731568873	0.96	33.19	34.55		178	0.00	33.934	36
406	MALE	2	90.0	129.13	56.64	3.94	32.78	3.907	42.1	4.88	5.03	54.18	80.07	3.716186106	0.95	33.05	34.75		178	0.00	35.260	33
406	MALE	2	100.0	193.26	84.76	4.45	43.77	4.884	52.6	4.88	5.03	54.18	100.08	5.45204	1.12	39.57	35.45	.	178	#VALUE!	#VALUE!	31
411	MALE	1	0.0	12.58	6.35	0.66	19.31	0.32	4.7	5.14	4.33	58.46	6.26	0.28	0.88	39.11	44.46	58	154	37.34	5.592	19
411	MALE	1	10.0	105.29	53.18	2.99	35.25	3.19	46.4	5.14	4.33	58.46	62.07	3.08	0.97	33.00	34.17	126	154	81.90	25.294	13
411	MALE	1	20.0	122.54	61.89	3.13	39.22	3.519	51.2	5.14	4.33	58.46	68.46	3.469233871	0.99	34.82	35.32	135	154	87.50	26.114	13
411	MALE	1	30.0	130.56	65.94	3.04	43.03	3.566	51.9	5.14	4.33	58.46	69.37	3.56555599	1.00	36.61	36.62	140	154	90.75	25.516	10
411	MALE	1	40.0	129.20	65.25	3.07	42.16	3.691	53.7	5.14	4.33	58.46	71.81	3.584630668	0.97	35.00	36.04	143	154	92.69	25.857	17
411	MALE	1	50.0	139.40	70.41	3.08	45.31	3.626	52.7	5.14	4.33	58.46	70.54	3.57801044	0.99	38.45	38.96	146	154	94.64	24.877	12
411	MALE	1	60.0	142.82	72.13	3.08	46.39	3.742	54.4	5.14	4.33	58.46	72.80	3.681030154	0.98	38.16	38.80	147	154	95.29	25.500	16
411	MALE	1	70.0	140.62	71.02	3.03	46.44	3.626	52.7	5.14	4.33	58.46	70.55	3.498007119	0.96	38.78	40.20	147	154	95.62	24.627	13
411	MALE	1	80.0	141.17	71.30	3.02	46.82	3.601	52.4	5.14	4.33	58.46	70.05	3.457121193	0.96	39.20	40.83	149	154	96.75	24.167	12
411	MALE	1	90.0	144.62	73.04	2.81	51.95	3.652	53.1	5.14	4.33	58.46	71.05	3.468321145	0.95	39.60	41.70	149	154	96.75	24.512	12
411	MALE	1	100.0	147.81	74.65	2.72	54.26	3.580	52.1	5.14	4.33	58.46	69.64	3.451398611	0.96	41.29	42.83	150	154	97.40	23.864	13
414	MALE	1	0.0	9.33	5.91	0.72	12.75	0.18	2.8	2.89	3.50	53.00	6.39	0.20	1.11	50.52	45.65	66	158	41.77	2.800	33
414	MALE	1	10.0	84.01	53.17	1.88	44.67	2.66	40.1	2.89	3.50	53.00	92.06	2.64	0.99	31.58	31.80	145	158	91.46	18.412	39
414	MALE	1	20.0	94.14	59.58	2.01	46.93	2.861	43.2	2.89	3.50	53.00	99.00	2.904540539	1.02	32.90	32.41	148	158	93.35	19.397	36
414	MALE	1	30.0	96.00	60.76	1.91	50.41	2.873	43.3	2.89	3.50	53.00	99.43	2.832290411	0.99	33.41	33.90	150	158	94.70	19.205	36
414	MALE	1	40.0	103.63	65.59	1.96	52.87	2.954	44.6	2.89	3.50	53.00	102.23	2.912280262	0.99	35.08	35.58	153	158	96.68	19.341	35
414	MALE	1	50.0	96.32	60.96	1.84	52.08	2.804	42.3	2.89	3.50	53.00	97.02	2.700977147	0.96	34.35	35.66	150	158	94.94	18.692	35
414	MALE	1	60.0	105.42	66.72	2.01	52.78	2.896	43.7	2.89	3.50	53.00	100.22	2.848810613	0.98	36.40	37.00	154	158	97.63	18.778	35
414	MALE	1	70.0	99.68	63.09	2.16	46.42	2.846	42.9	2.89	3.50	53.00	98.49	2.722274184	0.96	35.02	36.62	154	158	97.71	18.438	32
414	MALE	1	80.0	106.35	67.31	2.20	48.32	2.901	43.8	2.89	3.50	53.00	100.38	2.884614527	0.99	36.66	36.87	157	158	99.37	18.477	32
414	MALE	1	90.0	108.94	68.95	2.30	47.64	2.947	44.5	2.89	3.50	53.00	101.98	2.887831748	0.98	36.96	37.72	158	158	100.00	18.653	32
414	MALE	1	100.0	112.63	71.29	1.89	59.68	2.895	43.7	2.89	3.50	53.00	100.17	2.810434341	0.97	38.91	40.08	158	158	100.00	18.322	31.74
415	MALE	1	0.0	16.99	9.65	0.99	17.55	0.40	4.9	4.24	5.36	63.28	9.50	0.42	1.04	42.17	40.43	72	186	38.44	5.635	43
415	MALE	1	10.0	120.19	68.29	4.63	26.05	4.06	49.6	4.24	5.36	63.28	95.89	4.32	1.06	29.57	27.82	160	186	86.02	25.406	43
415	MALE	1	20.0	122.83	69.79	4.17	29.51	4.498	54.9	4.24	5.36	63.28	106.09	4.442080855	0.99	27.31	27.65	166	186	89.18	27.115	42
415	MALE	1	30.0	138.06	78.44	4.51	30.64	4.666	57.0	4.24	5.36	63.28	110.07	4.872918129	1.04	29.59	28.33	172	186	92.47	27.131	42
415	MALE	1	40.0	144.68	82.21	4.21	34.36	4.677	57.1	4.24	5.36	63.28	110.32	4.754268646	1.02	30.94	30.43	175	186	94.09	26.725	40
415	MALE	1	50.0	137.38	78.05	4.37	31.47	4.343	53.0	4.24	5.36	63.28	102.44	4.398182034	1.01	31.63	31.23	178	186	95.63	24.414	38
415	MALE	1	60.0	138.24	78.55	4.27	32.38	4.314	52.7	4.24	5.36	63.28	101.75	4.34236598	1.01	32.05	31.84	179	186	96.10	24.133	39
415	MALE	1	70.0	162.08	92.09	3.69	43.83	4.566	55.7	4.24	5.36	63.28	107.70	4.544113994	1.00	35.50	35.67	180	186	96.84	25.347	34
415	MALE	1	80.0	168.03	95.47	3.67	45.82	4.275	52.2	4.24	5.36	63.28	100.83	4.282747626	1.00	39.31	39.23	180	186	96.91	23.715	32
415	MALE	1	90.0	157.96	89.75	3.63	43.51	4.212	51.4	4.24	5.36	63.28	99.36	4.130407691	0.98	37.50	38.24	179	186	96.10	23.566	31
415	MALE	1	100.0	167.63	95.24	3.54	47.30	4.239	51.8	4.24	5.36	63.28	100.00	4.231212497	1.00	39.54	39.62	181	186	97.45	23.389	31

ID	GRP	Order	Prescribed Work	HR Mech TT	RPE TT	RPB TT	RPU TT	LEG PAIN	Blood Lactate TT	Reason TT	Reason Code CPX	Peak V_E Mech	MinVI Mech TT	MinVE Mech TT	VE/MVV Mech TT	VT Mech TT	VT/FVC Mech TT	fB Mech TT	Avg IC TT	Typ IC TT
405	MALE	1	0.0	.	6	0	0	0	2.3	.	.	.	-25.925	38.137	19.863	1.448	25.676	17.637	3.1605	3.055
405	MALE	1	10.0	.	9	1	1	1	.	.	.	.	-127.330	127.891	66.610	3.348	59.368	38.310	3.91433	3.998
405	MALE	1	20.0	.	12	3	3	3	.	.	.	.	-144.682	144.665	75.346	3.461	61.367	41.777	3.91769	4.021
405	MALE	1	30.0	.	13	4	4	4	.	.	.	.	-145.189	145.010	75.526	3.464	61.418	41.575	4.12662	4.087
405	MALE	1	40.0	.	13	4	5	4	.	.	.	.	-153.625	154.692	80.569	3.401	60.304	45.452	3.99469	4.097
405	MALE	1	50.0	.	13	5	5	5	11.7	.	.	.	-147.326	146.923	76.522	3.474	61.600	43.338	4.19375	4.194
405	MALE	1	60.0	.	13	4	5	5	.	.	.	.	-148.598	148.140	77.156	3.310	58.688	44.780	4.00575	4.051
405	MALE	1	70.0	.	13	5	5	5	.	.	.	.	-149.846	150.416	78.342	3.179	56.359	47.463	3.800273	3.714
405	MALE	1	80.0	.	13	6	5	5	.	.	.	.	-147.175	146.617	76.363	3.107	55.089	47.185	4.1219	4.079
405	MALE	1	90.0	.	14	6	5	6	.	.	.	.	-155.670	156.380	81.448	3.192	56.596	49.070	3.7415	3.768
405	MALE	1	100.0	.	17	8	7	7	12.1	.	.	.	-161.958	164.294	85.570	3.042	53.933	54.013	3.86633	3.854
406	MALE	2	0.0	66	6	0	0	0	1.5	.	.	.	-13.260	13.655	5.989	1.924	25.793	7.288	3.3075	3.357
406	MALE	2	10.0	133	7	0.5	0	0	.	.	.	.	-102.598	103.458	45.376	4.130	55.363	25.106	5.58769	5.648
406	MALE	2	20.0	140	9	1	0	0	.	.	.	.	-102.521	101.792	44.645	4.121	55.238	24.777	5.37809	5.339
406	MALE	2	30.0	143	11	2	0.5	0	.	.	.	.	-108.656	109.155	47.875	4.198	56.267	26.036	5.468273	5.514
406	MALE	2	40.0	150	12	2	0.5	0.5	.	.	.	.	-118.558	118.752	52.084	3.947	52.905	30.168	5.40275	5.368
406	MALE	2	50.0	154	12	3	0.5	0.5	4.4	.	.	.	-135.674	136.564	59.896	4.028	54.001	34.037	5.460231	5.454
406	MALE	2	60.0	156	12	3	0.5	0.5	.	.	.	.	-126.963	126.536	55.498	4.007	53.708	31.654	5.2475	5.103
406	MALE	2	70.0	160	12	4	0.5	0.5	.	.	.	.	-125.365	125.120	54.877	4.233	56.738	29.558	5.238182	5.182
406	MALE	2	80.0	162	12	4	1	1	.	.	.	.	-133.507	134.233	58.874	4.149	55.612	32.463	5.119154	5.052
406	MALE	2	90.0	.	12	4	0.5	1	.	.	.	.	-133.106	133.255	58.445	4.042	54.187	32.977	4.997636	4.939
406	MALE	2	100.0	.	19	9	0.5	3	8.8	.	.	.	-210.340	207.336	90.937	4.366	58.527	47.638	5.023077	5.233
411	MALE	1	0.0	55	6	0	0	0	1.5	.	.	.	-22.815	23.502	11.870	1.119	21.982	21.061	3.2236	3.081
411	MALE	1	10.0	120	9	0.5	0.5	0.5	.	.	.	.	-109.650	109.760	55.434	2.998	58.890	36.723	3.4967	3.493
411	MALE	1	20.0	129	10	1	1	1	.	.	.	.	-125.130	125.070	63.167	3.142	61.719	39.823	3.4833	3.425
411	MALE	1	30.0	134	11	2	2	2	.	.	.	.	-137.000	137.100	69.242	3.072	60.354	44.660	3.4237	3.308
411	MALE	1	40.0	138	12	2	2	2	.	.	.	.	-130.130	130.550	65.934	3.109	61.081	42.029	3.4386	3.391
411	MALE	1	50.0	140	13	3	3	3	8.4	.	.	.	-141.240	140.860	71.141	3.083	60.568	45.727	3.5061	3.467
411	MALE	1	60.0	142	14	4	4	3	.	.	.	.	-146.910	146.360	73.919	3.144	61.766	46.614	3.4645	3.488
411	MALE	1	70.0	144	14	4	4	4	.	.	.	.	-142.180	142.290	71.864	3.068	60.265	46.483	3.2967	3.301
411	MALE	1	80.0	143	15	4	5	5	.	.	.	.	-145.060	143.440	72.444	3.080	60.515	46.595	3.4355	3.382
411	MALE	1	90.0	143	16	4	5	5	.	.	.	.	-157.110	158.230	79.914	2.950	57.955	53.688	3.0205	2.957
411	MALE	1	100.0	145	18	5	5	5	8.7	.	.	.	-152.900	153.120	77.333	2.731	53.660	56.077	2.8977	2.918
414	MALE	1	0.0	62	6	1	0.5	0	1.1	.	.	.	-13.361	13.288	8.410	0.766	17.781	17.590	1.648	1.586
414	MALE	1	10.0	141	13	4	2	0	.	.	.	.	-90.283	91.3604	57.823	1.953	45.307	46.880	1.97054545	1.967
414	MALE	1	20.0	143	14	5	3	0.5	.	.	.	.	-99.324	99.895	63.224	2.066	47.935	48.347	2.22063636	2.282
414	MALE	1	30.0	146	15	7	4	2	.	.	.	.	-100.333	100.349	63.512	1.923	44.615	52.270	2.10936364	2.166
414	MALE	1	40.0	147	16	7	5	1	.	.	.	.	-109.360	109.417	69.251	1.983	45.999	55.266	2.21790909	2.238
414	MALE	1	50.0	148	15	7	4	2	4.8	.	.	.	-109.652	110.397	69.871	1.975	45.830	55.917	2.05036364	2.081
414	MALE	1	60.0	153	16	7	4	2	.	.	.	.	-109.646	109.456	69.276	1.976	45.843	55.392	2.16463636	2.242
414	MALE	1	70.0	150	17	6	4	2	.	.	.	.	-104.522	104.806	66.333	2.313	53.672	45.312	2.42581818	2.317
414	MALE	1	80.0	153	17	7	5	3	.	.	.	.	-109.926	108.902	68.925	2.199	51.023	49.803	2.34636364	2.38
414	MALE	1	90.0	159	17	8	7	3	.	.	.	.	-116.032	115.549	73.132	2.084	48.351	55.484	2.22345455	2.282
414	MALE	1	100.0	153	17	9	7	3	7.8	.	.	.	-118.890	117.641	74.457	1.938	44.961	60.849	2.14436364	2.156
415	MALE	1	0.0	69	6	0.5	0	0	1.9	.	.	.	-20.631	20.380	11.580	1.099	14.715	18.937	4.534	4.615
415	MALE	1	10.0	155	13	4	3	3	.	.	.	.	-127.562	127.600	72.500	4.833	64.698	26.439	5.91009091	5.989
415	MALE	1	20.0	162	14	5	4	4	.	.	.	.	-127.250	128.117	72.794	4.229	56.618	30.321	5.30890909	5.486
415	MALE	1	30.0	168	13	4	4	4	.	.	.	.	-141.765	143.845	81.730	4.587	61.407	31.439	5.51781818	5.403
415	MALE	1	40.0	169	14	5	5	4	.	.	.	.	-154.337	156.284	88.798	4.401	58.916	35.642	5.1381	5.183
415	MALE	1	50.0	174	14	5	5	4	12.7	.	.	.	-147.446	147.779	83.965	4.478	59.948	33.134	5.69709091	5.683
415	MALE	1	60.0	173	15	6	7	4	.	.	.	.	-149.204	148.572	84.416	4.460	59.702	33.326	5.39627273	5.455
415	MALE	1	70.0	176	15	7	7	5	.	.	.	.	-168.489	167.531	95.188	3.749	50.186	44.772	5.00309091	4.984
415	MALE	1	80.0	176	15	7	7	5	.	.	.	.	-174.494	175.270	99.585	3.815	51.075	45.941	4.98736364	5.054
415	MALE	1	90.0	175	15	6	7	5	.	.	.	.	-163.540	163.541	92.921	3.778	50.579	43.286	5.15654545	5.092
415	MALE	1	100.0	177	17	8	8	7	12.4	.	.	.	-174.407	174.357	99.067	3.658	48.964	47.646	4.93909091	4.804

ID	GRP	Order	Prescribed Work	EELVavg Mech TT	EELVtyp Mech TT	EELVavg %TLC TT	EELVtyp %TLC TT	EILVavg Mech TT	EILVtyp Mech TT	EILVavg %TLC TT	EILVtyp %TLC TT	Ti Mech TT	Te Mech TT	Ti/Ttot Mech TT	VT/Ti Mech TT	VT/Te Mech TT	PetCO2 Mech TT	expBTPS Mech	Max Pi Mech TT	Max Pe Mech TT	Int MP	Processing
405	MALE	1	0.0	5.21	5.32	62.240	131.886	6.658	6.763	79.541	80.802	3.514	1.335	2.179	0.412	1.085	35.893	1.067	-1.627	1.620	-1.410	EML
405	MALE	1	10.0	4.46	4.37	53.234	52.234	7.804	7.720	93.238	92.238	0.712	0.861	45.265	4.704	3.889	39.929	1.067	-6.187	7.445	-2.789	EML
405	MALE	1	20.0	4.45	4.35	53.194	51.959	7.913	7.810	94.545	93.310	0.644	0.798	44.660	5.376	4.339	39.048	1.067	-6.960	8.458	-2.959	EML
405	MALE	1	30.0	4.24	4.28	50.697	51.171	7.707	7.747	92.083	92.557	0.647	0.805	44.669	5.356	4.303	36.939	1.067	-7.220	8.525	-3.015	EML
405	MALE	1	40.0	4.38	4.27	52.274	51.051	7.776	7.674	92.909	91.686	0.593	0.732	44.829	5.732	4.648	34.939	1.067	-7.233	9.218	-2.938	EML
405	MALE	1	50.0	4.18	4.18	49.895	49.892	7.651	7.650	91.404	91.401	0.620	0.801	43.568	5.607	4.335	34.280	1.067	-7.153	9.019	-3.005	EML
405	MALE	1	60.0	4.36	4.32	52.142	51.601	7.674	7.629	91.688	91.147	0.575	0.772	42.834	5.759	4.288	33.540	1.067	-7.036	8.945	-2.839	EML
405	MALE	1	70.0	4.57	4.66	54.596	55.627	7.748	7.835	92.573	93.604	0.555	0.714	43.810	5.732	4.449	33.571	1.067	-6.969	8.905	-2.700	EML
405	MALE	1	80.0	4.25	4.29	50.754	51.266	7.355	7.398	87.875	88.387	0.574	0.701	45.060	5.409	4.431	33.420	1.067	-6.820	8.573	-2.632	EML
405	MALE	1	90.0	4.63	4.60	55.299	54.982	7.821	7.794	93.435	93.118	0.544	0.684	44.492	5.863	4.665	32.467	1.067	-7.298	9.081	-2.721	EML
405	MALE	1	100.0	4.50	4.52	53.807	53.955	7.546	7.558	90.149	90.297	1.11692	0.52408	0.59267	5.587	4.446	33.418	1.067	-7.521	10.175	-2.569	EML
406	MALE	2	0.0	7.46	7.41	69.290	136.771	9.387	9.337	87.155	86.696	3.523	5.061	41.181	0.546	0.380	35.618	1.067	-1.157	1.065	-2.403	EML
406	MALE	2	10.0	5.18	5.12	48.118	47.558	9.312	9.252	86.466	85.906	1.092	1.310	45.515	3.783	3.152	36.970	1.067	-4.118	4.666	-3.149	EML
406	MALE	2	20.0	5.39	5.43	50.064	50.427	9.513	9.552	88.325	88.688	1.083	1.353	44.460	3.804	3.046	37.225	1.067	-4.301	4.547	-3.209	EML
406	MALE	2	30.0	5.30	5.26	49.227	48.802	9.499	9.454	88.201	87.777	1.061	1.267	45.482	3.956	3.314	36.610	1.067	-4.559	5.103	-3.253	EML
406	MALE	2	40.0	5.37	5.40	49.835	50.158	9.314	9.349	86.481	86.804	0.889	1.108	44.537	4.440	3.562	35.582	1.067	-4.999	5.535	-3.132	EML
406	MALE	2	50.0	5.31	5.32	49.301	49.359	9.338	9.344	86.706	86.764	0.807	0.968	45.553	4.992	4.161	32.934	1.067	-5.735	6.931	-3.248	EML
406	MALE	2	60.0	5.52	5.67	51.277	52.618	9.529	9.674	88.478	89.820	0.865	1.042	45.428	4.632	3.847	33.664	1.067	-5.312	6.308	-3.234	EML
406	MALE	2	70.0	5.53	5.59	51.363	51.885	9.764	9.821	90.663	91.185	0.902	1.138	44.259	4.694	3.721	34.008	1.067	-5.528	6.060	-3.865	EML
406	MALE	2	80.0	5.65	5.72	52.468	53.092	9.800	9.867	90.989	91.613	0.840	1.021	45.123	4.941	4.064	32.550	1.067	-5.935	6.848	-3.398	EML
406	MALE	2	90.0	5.77	5.83	53.597	54.141	9.815	9.873	91.130	91.675	0.810	1.012	44.429	4.992	3.993	32.241	1.067	-5.937	6.476	-3.340	EML
406	MALE	2	100.0	5.75	5.54	53.360	51.411	10.113	9.903	93.900	91.951	0.579	0.689	45.820	7.547	6.336	30.433	1.067	-10.088	13.074	-4.222	EML
411	MALE	1	0.0	5.18	5.32	61.624	108.773	6.295	6.438	74.944	76.642	1.288	1.637	44.425	0.869	0.684	31.884	1.067	-1.447	1.427	-1.144	EML
411	MALE	1	10.0	4.90	4.91	58.373	58.417	7.901	7.905	94.057	94.101	0.813	0.830	49.451	3.686	3.611	36.046	1.067	-5.097	6.985	-2.459	EML
411	MALE	1	20.0	4.92	4.98	58.532	59.226	8.058	8.117	95.931	96.625	0.720	0.789	47.690	4.365	3.982	34.180	1.067	-5.892	7.975	-2.635	EML
411	MALE	1	30.0	4.98	5.09	59.242	60.619	8.048	8.164	95.813	97.190	0.650	0.696	48.271	4.725	4.414	32.769	1.067	-6.234	9.130	-2.625	EML
411	MALE	1	40.0	4.96	5.01	59.064	59.631	8.070	8.118	96.076	96.643	0.703	0.730	49.067	4.420	4.259	33.289	1.067	-6.030	9.018	-2.637	EML
411	MALE	1	50.0	4.89	4.93	58.261	58.726	7.977	8.016	94.962	95.427	0.649	0.666	49.357	4.750	4.627	32.005	1.067	-6.271	9.551	-2.629	EML
411	MALE	1	60.0	4.94	4.91	58.756	58.476	8.079	8.056	96.183	95.904	0.639	0.650	49.605	4.917	4.836	30.596	1.067	-6.488	10.801	-2.715	EML
411	MALE	1	70.0	5.10	5.10	60.754	60.702	8.171	8.167	97.271	97.220	0.670	0.625	51.735	4.578	4.906	30.130	1.067	-6.071	10.757	-2.559	EML
411	MALE	1	80.0	4.96	5.02	59.101	59.738	8.045	8.098	95.770	96.407	0.673	0.617	52.121	4.578	4.991	29.571	1.067	-5.854	11.425	-2.560	EML
411	MALE	1	90.0	5.38	5.44	64.042	64.798	8.329	8.393	99.160	99.915	0.557	0.562	49.768	5.296	5.251	29.101	1.067	-6.901	11.392	-2.512	EML
411	MALE	1	100.0	5.50	5.48	65.504	65.262	8.234	8.213	98.019	97.777	0.538	0.532	50.283	5.073	5.134	28.323	1.067	-6.275	10.667	-2.287	EML
414	MALE	1	0.0	5.58	5.64	77.206	187.508	6.348	6.410	87.806	88.664	1.559	1.899	45.065	0.492	0.404	32.859	1.067	-1.148	0.854	-1.279	EML
414	MALE	1	10.0	5.26	5.26	72.745	72.794	7.212	7.216	99.754	99.803	0.56136	0.72073	43.8327	3.479	2.709	39.142	1.067	-4.0622	4.382	-1.5719	EML
414	MALE	1	20.0	5.01	4.95	69.286	68.437	7.075	7.014	97.861	97.012	0.542	0.700	43.686	3.809	2.951	36.480	1.067	-4.456	5.122	-1.672	EML
414	MALE	1	30.0	5.12	5.06	70.825	70.041	7.044	6.987	97.421	96.638	0.504	0.646	43.818	3.814	2.975	34.163	1.067	-4.423	4.934	-1.572	EML
414	MALE	1	40.0	5.01	4.99	69.324	69.046	6.995	6.975	96.745	96.467	0.490	0.597	45.092	4.046	3.319	33.570	1.067	-4.571	5.633	-1.608	EML
414	MALE	1	50.0	5.18	5.15	71.641	71.217	7.155	7.124	98.961	98.538	0.483	0.593	44.870	4.093	3.331	33.099	1.067	-4.715	5.632	-1.612	EML
414	MALE	1	60.0	5.07	4.99	70.060	68.990	7.041	6.964	97.388	96.318	0.479	0.605	44.215	4.125	3.265	32.420	1.067	-4.668	5.435	-1.617	EML
414	MALE	1	70.0	4.80	4.91	66.448	67.953	7.117	7.226	98.443	99.948	0.556	0.771	41.981	4.159	3.000	34.781	1.067	-4.744	5.550	-1.885	EML
414	MALE	1	80.0	4.88	4.85	67.547	67.082	7.083	7.049	97.963	97.498	0.510	0.706	42.175	4.309	3.113	32.405	1.067	-5.208	6.807	-1.825	EML
414	MALE	1	90.0	5.01	4.95	69.247	68.437	7.090	7.032	98.070	97.260	0.486	0.597	44.907	4.288	3.493	31.447	1.067	-4.962	6.236	-1.705	EML
414	MALE	1	100.0	5.09	5.07	70.341	70.180	7.023	7.012	97.143	96.982	0.450	0.538	45.586	4.305	3.603	30.379	1.067	-5.266	6.237	-1.628	EML
415	MALE	1	0.0	4.16	4.08	47.825	93.894	5.255	5.174	60.474	59.542	1.291	1.973	39.879	0.851	0.557	35.881	1.067	-1.301	1.398	-1.238	EML
415	MALE	1	10.0	2.78	2.70	31.990	31.082	7.613	7.534	87.604	86.696	1.056	1.224	46.326	4.579	3.950	41.242	1.067	-5.604	9.805	-4.059	EML
415	MALE	1	20.0	3.38	3.20	38.908	36.870	7.610	7.433	87.577	85.539	0.925	1.058	46.632	4.573	3.998	40.915	1.067	-6.326	8.587	-3.634	EML
415	MALE	1	30.0	3.17	3.29	36.504	37.825	7.759	7.874	89.290	90.611	0.864	1.048	45.201	5.310	4.376	40.320	1.067	-7.712	11.609	-3.915	EML
415	MALE	1	40.0	3.55	3.51	40.873	40.357	7.953	7.908	91.518	91.001	0.759	0.939	44.788	5.795	4.688	36.526	1.067	-7.479	11.027	-3.865	EML
415	MALE	1	50.0	2.99	3.01	34.441	34.603	7.471	7.485	85.972	86.135	0.813	1.014	44.458	5.508	4.414	36.635	1.067	-7.934	10.831	-3.946	EML
415	MALE	1	60.0	3.29	3.24	37.903	37.227	7.753	7.695	89.223	88.547	0.817	0.994	45.030	5.460	4.487	35.288	1.067	-7.531	10.235	-3.949	EML
415	MALE	1	70.0	3.69	3.71	42.427	42.647	7.436	7.455	85.568	85.787	0.617	0.733	45.609	6.075	5.116	30.530	1.067	-8.296	11.654	-3.403	EML
415	MALE	1	80.0	3.70	3.64	42.608	41.841	7.518	7.451	86.512	85.745	0.609	0.704	46.269	6.269	5.419	29.420	1.067	-8.124	11.941	-3.429	EML
415	MALE	1	90.0	3.53	3.60	40.661	41.404	7.312	7.376	84.140	84.882	0.606	0.783	43.646	6.237	4.824	29.681	1.067	-7.629	10.453	-3.384	EML
415	MALE	1	100.0	3.75	3.89	43.164	44.718	7.409	7.544	85.254	86.808	0.586	0.676	46.470	6.242	5.414	29.239	1.067	-8.679	12.375	-3.348	EML

Appendix A.e: Raw Data - Placebo Time Trial

ID	GRP	Order	Prescribed Work	Work (J)	Work (%)	AGE	HT (cm)	WT (kg)	Sex	TLC	FRC	FVC	MVV	P_B	TT Watts
400	MALE	1	0.0		0.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	
400	MALE	1	10.0		10.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	344.58
400	MALE	1	20.0		20.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	329.083
400	MALE	1	30.0		30.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	321.652
400	MALE	1	40.0		40.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	306.823
400	MALE	1	50.0		50.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	303.912
400	MALE	1	60.0		60.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	311.024
400	MALE	1	70.0		70.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	313.993
400	MALE	1	80.0		80.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	305.246
400	MALE	1	90.0		90.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	317.436
400	MALE	1	100.0		100.0	24	191.0	78.2	M	7.97	4.11	6.40	236	681.0	398.182
402	MALE	1	0.0		0.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	
402	MALE	1	10.0		10.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	212.914
402	MALE	1	20.0		20.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	231.145
402	MALE	1	30.0		30.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	248.602
402	MALE	1	40.0		40.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	252.481
402	MALE	1	50.0		50.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	260.452
402	MALE	1	60.0		60.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	258.025
402	MALE	1	70.0		70.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	270.579
402	MALE	1	80.0		80.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	259.091
402	MALE	1	90.0		90.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	267.657
402	MALE	1	100.0		100.0	19	183.0	70.0	M	7.88	4.94	5.67	193	683.0	289.72
403	MALE	1	0.0		0.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	
403	MALE	1	10.0		10.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	162.764
403	MALE	1	20.0		20.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	160.349
403	MALE	1	30.0		30.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	161.538
403	MALE	1	40.0		40.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	163.968
403	MALE	1	50.0		50.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	160.538
403	MALE	1	60.0		60.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	165.935
403	MALE	1	70.0		70.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	167.828
403	MALE	1	80.0		80.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	166.793
403	MALE	1	90.0		90.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	176.719
403	MALE	1	100.0		100.0	26	173.0	56.8	M	6.71	3.20	5.25	164	683.0	181.553
404	MALE	2	0.0		0.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	
404	MALE	2	10.0		10.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	223.915
404	MALE	2	20.0		20.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	245.153
404	MALE	2	30.0		30.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	255.308
404	MALE	2	40.0		40.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	263.103
404	MALE	2	50.0		50.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	271.647
404	MALE	2	60.0		60.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	268.306
404	MALE	2	70.0		70.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	273.228
404	MALE	2	80.0		80.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	275.956
404	MALE	2	90.0		90.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	288.152
404	MALE	2	100.0		100.0	35	173.0	69.6	M	7.64	4.32	5.59	254	681.0	327.744

ID	GRP	Order	Prescribed Work	V_E TT	V_E/MVV TT	V_T TT	f_B TT	VO_2 TT	VO_2 ml/kg TT	Peak VO_2 TT	PerVO_2 TT	VCO_2 TT	RER TT	V_E/VO_2 TT	V_E/VCO_2 TT	HR TT	PHR TT	HR PP TT	O2Pul TT	$PetCO_2$ TT
400	MALE	1	0.0	9.68	4.10	0.85	11.46	0.25	3.1	4.96	5.02	0.26	1.04	38.87	37.49	64	180	35.69	3.877	31
400	MALE	1	10.0	141.69	60.04	3.30	43.02	4.30	55.0	4.96	86.72	4.28	0.99	32.93	33.14	155	180	85.97	27.807	25
400	MALE	1	20.0	139.04	58.92	3.04	45.80	4.365	55.8	4.96	87.96	4.04399	0.93	31.85	34.38	158	180	87.64	27.670	20
400	MALE	1	30.0	119.28	50.54	3.03	39.95	3.921	50.1	4.96	79.02	3.49201	0.89	30.42	34.16	156	180	86.46	25.197	17
400	MALE	1	40.0	128.78	54.57	2.75	46.78	3.995	51.1	4.96	80.50	3.60842	0.90	32.24	35.69	154	180	85.69	25.897	23
400	MALE	1	50.0	125.79	53.30	2.81	45.65	4.082	52.2	4.96	82.26	3.67811	0.90	30.82	34.20	157	180	87.22	25.999	19
400	MALE	1	60.0	129.83	55.01	2.84	45.75	3.988	51.0	4.96	80.37	3.60999	0.91	32.55	35.96	158	180	87.92	25.202	18
400	MALE	1	70.0	142.51	60.38	2.79	51.10	4.228	54.1	4.96	85.21	3.84184	0.91	33.70	37.09	161	180	89.38	26.284	19
400	MALE	1	80.0	138.60	58.73	2.83	49.12	4.365	55.8	4.96	87.96	3.87668	0.89	31.75	35.75	161	180	89.17	27.195	19
400	MALE	1	90.0	149.69	63.43	2.91	51.52	4.346	55.6	4.96	87.57	4.09343	0.94	34.45	36.57	166	180	92.22	26.178	20
400	MALE	1	100.0	216.26	91.64	3.26	66.44	4.962	63.5	4.96	100.00	5.69801	1.15	43.58	37.95	176	180	97.71	28.214	20
402	MALE	1	0.0	14.50	7.51	0.64	22.95	0.31	4.4	4.12	7.54	0.36	1.16	46.64	40.31	71	188	37.77	6.999	30
402	MALE	1	10.0	35.63	18.46	2.30	31.04	2.51	35.8	4.12	60.89	2.40	0.96	14.20	14.83	141	188	75.20	17.747	28
402	MALE	1	20.0	45.27	23.46	2.23	48.98	3.187	45.5	4.12	77.36	3.2544	1.02	14.20	13.91	154	188	82.05	20.663	37
402	MALE	1	30.0	47.62	24.67	2.44	43.12	3.352	47.9	4.12	81.37	3.30523	0.99	14.20	14.41	158	188	84.04	21.226	40
402	MALE	1	40.0	48.83	25.30	2.29	47.90	3.438	49.1	4.12	83.44	3.36112	0.98	14.20	14.53	166	188	88.23	20.726	35
402	MALE	1	50.0	48.53	25.15	2.42	47.54	3.417	48.8	4.12	82.93	3.41044	1.00	14.20	14.23	167	188	89.03	20.413	26
402	MALE	1	60.0	49.89	25.85	2.77	41.80	3.512	50.2	4.12	85.24	3.52259	1.00	14.20	14.16	172	188	91.62	20.375	35
402	MALE	1	70.0	46.78	24.24	2.41	49.73	3.293	47.0	4.12	79.94	3.3508	1.02	14.20	13.96	177	188	94.02	18.630	35
402	MALE	1	80.0	52.31	27.11	2.45	49.77	3.683	52.6	4.12	89.39	3.46822	0.94	14.20	15.08	177	188	94.08	20.821	35
402	MALE	1	90.0	55.23	28.62	2.67	51.83	3.888	55.5	4.12	94.38	3.8752	1.00	14.20	14.25	182	188	96.68	21.392	35
402	MALE	1	100.0	58.59	30.36	2.73	63.32	4.125	58.9	4.12	100.12	4.42183	1.07	14.20	39.07	187	188	#REF!	22.041	35
403	MALE	1	0.0	11.86	7.23	0.89	14.68	0.29	5.1	2.87	10.18	0.29	0.99	40.62	40.98	83	176	47.16	3.518	.
403	MALE	1	10.0	68.36	41.68	3.11	22.02	2.24	39.5	2.87	78.27	2.36	1.05	30.46	28.93	153	176	86.79	14.690	.
403	MALE	1	20.0	95.85	58.45	3.60	26.59	2.189	38.5	2.87	76.37	2.34876	1.07	43.78	40.81	155	176	88.07	14.126	.
403	MALE	1	30.0	91.41	55.74	3.11	29.50	2.572	45.3	2.87	89.73	2.4285	0.94	35.53	37.64	163	176	92.68	15.770	.
403	MALE	1	40.0	90.65	55.28	3.51	25.85	2.508	44.2	2.87	87.49	2.44009	0.97	36.14	37.15	164	176	93.11	15.307	.
403	MALE	1	50.0	69.42	42.33	2.64	26.15	2.110	37.1	2.87	73.59	1.94853	0.92	32.91	35.63	161	176	91.59	13.088	.
403	MALE	1	60.0	83.99	51.21	3.71	22.68	2.559	45.1	2.87	89.26	2.52315	0.99	32.82	33.29	164	176	93.11	15.615	.
403	MALE	1	70.0	88.98	54.26	3.13	28.49	2.623	46.2	2.87	91.47	2.52252	0.96	33.93	35.28	167	176	95.03	15.681	.
403	MALE	1	80.0	86.09	52.49	3.01	28.59	2.573	45.3	2.87	89.76	2.4731	0.96	33.45	34.81	171	176	96.88	15.093	.
403	MALE	1	90.0	85.52	52.15	2.90	29.51	2.605	45.9	2.87	90.85	2.50671	0.96	32.84	34.12	170	176	96.59	15.321	.
403	MALE	1	100.0	86.38	52.67	2.64	32.77	2.661	46.9	2.87	92.82	2.59964	0.98	32.46	33.23	176	176	99.72	15.164	.
404	MALE	2	0.0	10.41	4.10	0.65	17.06	0.29	4.2	4.49	6.43	0.24	0.84	35.99	43.06	55	182	30.22	5.257	34
404	MALE	2	10.0	90.04	35.45	2.65	34.08	3.13	44.9	4.49	69.55	2.68	0.86	28.80	33.66	141	182	77.34	22.209	36
404	MALE	2	20.0	100.74	39.66	2.64	38.18	3.352	48.2	4.49	74.57	2.96157	0.88	30.05	34.01	150	182	82.42	22.346	37
404	MALE	2	30.0	100.89	39.72	2.79	36.22	3.379	48.5	4.49	75.17	2.97627	0.88	29.86	33.90	156	182	85.44	21.728	36
404	MALE	2	40.0	108.95	42.89	2.89	37.55	3.613	51.9	4.49	80.39	3.17585	0.88	30.15	34.30	158	182	87.03	22.811	35
404	MALE	2	50.0	111.04	43.72	2.97	37.51	3.550	51.0	4.49	78.98	3.16482	0.89	31.28	35.09	162	182	88.94	21.929	34
404	MALE	2	60.0	130.40	51.34	2.88	45.21	3.791	54.5	4.49	84.35	3.44937	0.91	34.40	37.81	165	182	90.38	23.047	33
404	MALE	2	70.0	127.52	50.20	2.80	46.09	3.768	54.1	4.49	83.83	3.35161	0.89	33.84	38.05	167	182	91.90	22.529	32
404	MALE	2	80.0	142.10	55.94	2.99	47.61	4.031	57.9	4.49	89.68	3.64522	0.90	35.25	38.98	171	182	93.96	23.571	37
404	MALE	2	90.0	149.89	59.01	3.17	47.27	4.302	61.8	4.49	95.70	3.88053	0.90	34.85	38.63	175	182	96.29	24.545	31
404	MALE	2	100.0	185.59	73.07	3.24	57.27	4.495	64.6	4.49	100.00	4.41964	0.98	41.29	41.99	175	182	96.29	25.647	30

ID	GRP	Order	Prescribed Work	PulseOx TT	HR Mech TT	Instanteous Power	RPE TT	RPB TT	RPU TT	LEG PAIN	Blood Lactate TT	Reason TT	Reason Code CPX	Peak V_E Mech TT	MinVI Mech TT	MinVE Mech TT	VE/MVV Mech TT	VT Mech TT	VT/FVC Mech TT	fB Mech TT	Avg IC TT	Typ IC TT
400	MALE	1	0.0	.	.		6	0	0	0	.	.	.	.	-13.742	13.888	5.885	1.097	17.141	12.878	3.5988	3.624
400	MALE	1	10.0	.	.		13	4	3	2	.	.	.	.	-154.580	153.430	65.013	3.271	51.114	46.960	4.6045	4.609
400	MALE	1	20.0	.	.		14	4	2	3	.	.	.	.	-141.890	143.730	60.903	3.126	48.836	46.074	4.541	4.636
400	MALE	1	30.0	.	.		14	5	4	3	.	.	.	.	-132.280	131.320	55.644	2.991	46.738	43.967	4.3878	4.423
400	MALE	1	40.0	.	.		14	5	4	3	.	.	.	.	-124.270	124.090	52.581	2.751	42.989	45.159	4.4375	4.451
400	MALE	1	50.0	.	.		13	5	3	4	.	.	.	.	-136.540	136.400	57.797	2.807	43.861	48.690	4.366	4.322
400	MALE	1	60.0	.	.		13	5	4	4	.	.	.	.	-137.400	138.110	58.521	2.761	43.145	50.043	4.3069	4.241
400	MALE	1	70.0	.	.		14	4	5	5	.	.	.	.	-149.710	150.180	63.636	2.911	45.478	51.698	4.3417	4.392
400	MALE	1	80.0	.	.		13	5	4	4	.	.	.	.	-142.870	143.410	60.767	2.820	44.066	50.903	4.2345	4.158
400	MALE	1	90.0	.	.		15	7	6	5	.	.	.	.	-156.270	155.670	65.962	2.952	46.131	52.828	4.0898	4.183
400	MALE	1	100.0	.	.		19	9	9	8	.	.	.	.	-227.290	227.480	96.390	3.385	52.889	67.318	4.1928	4.048
402	MALE	1	0.0	.	.		6	3	1	1	1	.	.	.	-19.668	18.793	9.737	1.374	24.233	19.826	2.43775	2.634
402	MALE	1	10.0	.	.		12	4	3	3	.	.	.	.	-83.271	82.577	42.786	2.685	47.358	31.284	4.08122	3.882
402	MALE	1	20.0	.	.		13	4	4	4	.	.	.	.	-112.957	112.344	58.209	2.237	39.457	50.489	3.4891	3.452
402	MALE	1	30.0	.	.		14	5	5	5	.	.	.	.	-116.864	116.897	60.568	2.794	49.285	41.871	3.69618	3.699
402	MALE	1	40.0	.	.		15	6	6	6	.	.	.	.	-124.572	124.010	64.254	2.537	44.752	49.544	3.59854	3.72
402	MALE	1	50.0	.	.		15	7	6	6	3.7	.	.	.	-118.219	118.280	61.285	2.811	49.568	42.669	4.2278	4.086
402	MALE	1	60.0	.	.		16	6	6	6	.	.	.	.	-129.037	128.686	66.677	2.833	49.965	45.553	3.5908	3.509
402	MALE	1	70.0	.	.		17	7	7	7	.	.	.	.	-136.753	136.471	70.710	2.518	44.404	54.812	3.6315	3.632
402	MALE	1	80.0	.	.		17	8	8	7	.	.	.	.	-147.464	148.190	76.782	2.827	49.854	52.761	3.25636	2.972
402	MALE	1	90.0	.	.		18	8	8	8	.	.	.	.	-151.336	152.028	78.771	2.568	45.293	59.350	3.29308	3.354
402	MALE	1	100.0	.	.		19	9	8	8	9.1	.	.	.	-182.437	182.148	94.377	2.870	50.623	63.874	3.50608	3.572
403	MALE	1	0.0	.	.		6	0	0	0	2.4	.	.	.	-14.824	14.205	8.661	0.839	15.988	17.098	3.38918	3.669
403	MALE	1	10.0	.	.		10	0.5	0	2	.	.	.	.	-72.05	73.03	44.530	3.335	63.531	21.909	3.6219	3.556
403	MALE	1	20.0	.	.		11	0.5	0	2	.	.	.	.	-100.41	99.687	60.785	3.606	68.686	27.625	4.0614	3.969
403	MALE	1	30.0	.	.		10	0.5	0	2	.	.	.	.	-93.88	94.261	57.476	3.152	60.034	30.029	3.6218	3.778
403	MALE	1	40.0	.	.		11	1	0	3	.	.	.	.	-90.461	90.971	55.470	3.550	67.617	25.616	3.5896	3.518
403	MALE	1	50.0	.	.		11	0.5	0.5	3	7.1	.	.	.	-81.19	80.774	49.252	2.959	56.354	27.327	3.8872	3.896
403	MALE	1	60.0	.	.		12	3	0.5	4	.	.	.	.	-82.4845	82.6145	50.375	3.751	71.441	22.0417	3.75245	3.831
403	MALE	1	70.0	.	.		13	3	1	5	.	.	.	.	-88.461	89	54.268	3.075	58.573	29.046	3.7046	3.62
403	MALE	1	80.0	.	.		14	3	1	5	.	.	.	.	-87.958	88.059	53.695	3.103	59.097	28.424	3.5798	3.581
403	MALE	1	90.0	.	.		14	4	2	5	.	.	.	.	-87.302	87.108	53.115	2.929	55.783	29.799	3.3665	3.244
403	MALE	1	100.0	.	.		16	5	3	6	8	.	.	.	-89.551	89.216	54.400	2.702	51.470	33.034	3.23355	3.185
404	MALE	2	0.0	96	46		6	0	0	0	0.6	.	.	.	-14.880	14.994	5.903	0.989	17.694	15.124	2.9315	2.968
404	MALE	2	10.0	95	137		7	0	0	0.5	.	.	.	.	-99.689	99.301	39.095	2.809	50.245	35.384	3.6024	3.693
404	MALE	2	20.0	94	146		8	0.5	0.5	1	.	.	.	.	-103.020	102.880	40.504	2.756	49.306	37.336	3.6548	3.641
404	MALE	2	30.0	93	151		8	0.5	0.5	1	.	.	.	.	-106.100	105.690	41.610	2.927	52.358	36.146	3.4174	3.24
404	MALE	2	40.0	92	153		8	1	1	1	.	.	.	.	-125.710	125.630	49.461	3.083	55.154	40.758	3.5649	3.508
404	MALE	2	50.0	93	158		8	1	2	2	3.8	.	.	.	-130.850	131.080	51.606	3.068	54.882	42.682	3.6518	3.607
404	MALE	2	60.0	93	160		8	2	2	2	.	.	.	.	-135.610	134.170	52.823	3.009	53.834	44.586	3.5325	3.617
404	MALE	2	70.0	92	163		9	2	2	2	.	.	.	.	-135.410	135.310	53.272	3.130	55.986	43.203	3.7624	3.799
404	MALE	2	80.0	93	167		10	2	2	4	.	.	.	.	-144.900	145.350	57.224	3.115	55.717	46.711	3.7554	3.721
404	MALE	2	90.0	92	170		11	4	3	4	.	.	.	.	-161.990	161.730	63.673	3.276	58.601	49.380	3.809	3.791
404	MALE	2	100.0	92	178		15	5	4	5	7.9	.	.	.	-201.690	201.880	79.480	3.410	61.009	59.225	3.7893	3.847

ID	GRP	Order	Prescribed Work	EELVavg Mech TT	EELVtyp Mech TT	EELVavg %TLC TT	EELVtyp %TLC TT	EILVavg Mech TT	EILVtyp Mech TT	EILVavg %TLC TT	EILVtyp %TLC TT	Ti Mech TT	Te Mech TT	Ti/Ttot Mech TT	VT/Ti Mech TT	VT/Te Mech TT	PetCO2 Mech TT	Max Pi Mech TT	Max Pe Mech TT	Int MP	expBTPS Mech TT	Processing
400	MALE	1	0.0	4.37	4.35	54.846	105.742	5.468	5.443	68.610	68.294	1.860	2.900	39.033	0.590	0.378	39.924	-1.385	1.104	-1.421	1.067	EML
400	MALE	1	10.0	3.37	3.36	42.227	42.171	6.637	6.632	83.272	83.216	0.594	0.685	46.426	5.506	4.775	37.660	-6.173	8.437	-2.714	1.067	EML
400	MALE	1	20.0	3.43	3.33	43.024	41.832	6.555	6.460	82.240	81.048	0.610	0.701	46.574	5.125	4.459	37.492	-5.473	7.529	-1.660	1.067	EML
400	MALE	1	30.0	3.58	3.55	44.946	44.504	6.573	6.538	82.477	82.035	0.639	0.733	46.466	4.681	4.080	38.083	-5.135	6.907	-2.432	1.067	EML
400	MALE	1	40.0	3.53	3.52	44.322	44.153	6.284	6.270	78.843	78.674	0.615	0.718	46.177	4.471	3.832	38.421	-4.765	6.426	-2.198	1.067	EML
400	MALE	1	50.0	3.60	3.65	45.220	45.772	6.411	6.455	80.440	80.992	0.572	0.665	46.282	4.906	4.222	37.905	-5.352	7.256	-2.265	1.067	EML
400	MALE	1	60.0	3.66	3.73	45.961	46.788	6.424	6.490	80.607	81.434	0.560	0.640	46.671	4.934	4.312	37.066	-5.266	7.250	-2.206	1.067	EML
400	MALE	1	70.0	3.63	3.58	45.524	44.893	6.539	6.489	82.044	81.413	0.546	0.618	46.964	5.330	4.712	35.982	-5.977	7.799	-2.362	1.067	EML
400	MALE	1	80.0	3.74	3.81	46.870	47.829	6.556	6.632	82.255	83.215	0.553	0.627	46.857	5.102	4.495	36.482	-5.486	7.646	-2.272	1.067	EML
400	MALE	1	90.0	3.88	3.79	48.685	47.516	6.833	6.739	85.729	84.560	0.525	0.614	46.173	5.621	4.812	35.306	-6.182	8.369	-2.413	1.067	EML
400	MALE	1	100.0	3.78	3.92	47.393	49.210	7.162	7.307	89.863	91.680	0.428	0.465	47.892	7.917	7.282	32.768	-10.349	15.137	-3.108	1.067	EML
402	MALE	1	0.0	5.44	5.25	69.064	106.194	6.816	6.620	86.501	84.010	1.649	2.800	38.247	0.833	0.491	33.728	-1.874	1.986	-1.561	1.067	EML
402	MALE	1	10.0	3.80	4.00	48.208	50.736	6.484	6.683	82.284	84.812	1.005	0.973	51.211	2.672	2.760	42.025	-3.537	5.882	-2.262	1.067	EML
402	MALE	1	20.0	4.39	4.43	55.722	56.193	6.628	6.665	84.113	84.584	0.623	0.590	51.344	3.592	3.794	37.509	-4.326	7.039	-1.828	1.067	EML
402	MALE	1	30.0	4.18	4.18	53.094	53.058	6.978	6.975	88.557	88.521	0.742	0.702	51.448	3.765	3.980	36.749	-4.523	7.354	-2.257	1.067	EML
402	MALE	1	40.0	4.28	4.16	54.333	52.792	6.819	6.697	86.535	84.993	0.630	0.602	51.139	4.026	4.212	36.221	-4.818	8.389	-2.049	1.067	EML
402	MALE	1	50.0	3.65	3.79	46.348	48.147	6.463	6.605	82.014	83.813	0.698	0.781	49.185	4.024	3.598	35.543	-4.874	8.068	-2.255	1.067	EML
402	MALE	1	60.0	4.29	4.37	54.431	55.470	7.122	7.204	90.383	91.421	0.667	0.661	50.331	4.245	4.283	34.632	-5.034	7.996	-2.812	1.067	EML
402	MALE	1	70.0	4.25	4.25	53.915	53.909	6.766	6.766	85.865	85.859	0.537	0.581	48.082	4.687	4.333	34.317	-5.538	7.721	-2.079	1.067	EML
402	MALE	1	80.0	4.62	4.91	58.676	62.284	7.450	7.735	94.547	98.156	0.596	0.564	51.366	4.743	5.009	31.332	-5.816	10.573	-2.370	1.067	EML
402	MALE	1	90.0	4.59	4.53	58.210	57.437	7.155	7.094	90.800	90.027	0.493	0.524	48.513	5.205	4.897	30.885	-6.340	9.670	-2.145	1.067	EML
402	MALE	1	100.0	4.37	4.31	55.507	54.670	7.244	7.178	91.932	91.095	0.462	0.489	48.656	6.209	5.869	29.383	-7.658	12.162	-2.523	1.067	EML
403	MALE	1	0.0	3.32	3.04	49.491	95.031	4.160	3.880	62.000	57.830	1.293	2.299	36.026	0.649	0.365	38.766	-1.820	1.820	-0.959	1.067	EML
403	MALE	1	10.0	2.54	3.15	37.864	47.004	5.876	6.489	87.572	96.712	1.43382	1.30918	52.3118	2.387	1.912	40.771	-3.90364	5.85173	-2.63453	1.067	EML
403	MALE	1	20.0	2.56	2.74	38.116	40.849	6.164	6.347	91.857	94.590	1.075	1.11692	48.752	2.298	2.029	30.734	-4.52154	8.00985	-2.84539	1.067	EML
403	MALE	1	30.0	2.94	2.93	43.752	43.696	6.088	6.084	90.724	90.668	1.01692	0.99225	50.4948	2.100	1.982	33.114	-4.37192	8.5015	-2.4684	1.067	EML
403	MALE	1	40.0	2.78	3.19	41.359	47.571	6.325	6.742	94.264	100.475	1.10908	1.24108	47.243	2.622	1.997	32.443	-4.44683	8.49992	-2.73292	1.067	EML
403	MALE	1	50.0	3.18	2.81	47.351	41.937	6.136	5.773	91.443	86.030	1.16517	1.03942	52.7958	2.042	2.099	35.316	-3.6705	6.96533	-2.30269	1.067	EML
403	MALE	1	60.0	3.18	2.88	47.351	42.906	6.928	6.630	103.247	98.802	1.34836	1.39036	49.1127	2.991	2.813	36.1945	-4.61391	7.11691	-2.23726	1.067	EML
403	MALE	1	70.0	3.40	3.09	50.709	46.051	6.478	6.165	96.537	91.879	0.98531	1.08662	47.6604	2.871	2.722	33.81	-4.35931	6.96854	-2.41373	1.067	EML
403	MALE	1	80.0	3.39	3.13	50.502	46.632	6.491	6.232	96.740	92.870	1.02577	1.08815	48.5267	3.221	3.207	34.881	-4.41208	7.22531	-2.44586	1.067	EML
403	MALE	1	90.0	3.51	3.47	52.378	51.654	6.443	6.395	96.024	95.300	1.019	1.0015	50.4605	3.422	3.417	34.574	-4.32275	7.49142	-2.30972	1.067	EML
403	MALE	1	100.0	3.48	3.53	51.810	52.534	6.179	6.227	92.081	92.804	0.916	0.908	50.179	2.949	2.976	35.770	-4.587	6.992	-2.13216	1.067	EML
404	MALE	2	0.0	4.71	4.67	61.630	108.148	5.698	5.661	74.576	74.098	1.239	2.747	31.197	0.798	0.360	33.460	-1.242	1.061	-0.877	1.067	EML
404	MALE	2	10.0	4.04	3.95	52.848	51.662	6.846	6.756	89.611	88.425	0.778	0.920	45.842	3.608	3.052	35.923	-4.402	5.182	-2.302	1.067	EML
404	MALE	2	20.0	3.99	4.00	52.162	52.343	6.741	6.755	88.238	88.419	0.742	0.874	45.755	3.712	3.154	36.182	-4.537	5.394	-2.287	1.067	EML
404	MALE	2	30.0	4.22	4.40	55.270	57.592	7.149	7.327	93.579	95.901	0.827	0.853	48.814	3.541	3.430	36.126	-4.323	6.087	-2.386	1.067	EML
404	MALE	2	40.0	4.08	4.13	53.339	54.084	7.158	7.215	93.694	94.438	0.672	0.803	45.633	4.586	3.838	33.955	-5.551	6.981	-2.536	1.067	EML
404	MALE	2	50.0	3.99	4.03	52.202	52.788	7.056	7.101	92.357	92.944	0.668	0.745	47.037	4.596	4.119	32.931	-5.740	7.644	-2.529	1.067	EML
404	MALE	2	60.0	4.11	4.02	53.763	52.657	7.117	7.032	93.152	92.046	0.631	0.716	46.826	4.773	4.204	32.181	-6.198	7.909	-2.516	1.067	EML
404	MALE	2	70.0	3.88	3.84	50.754	50.275	7.007	6.971	91.717	91.238	0.660	0.734	47.138	4.741	4.263	32.053	-5.825	8.217	-2.570	1.067	EML
404	MALE	2	80.0	3.88	3.92	50.846	51.296	6.999	7.034	91.613	92.063	0.610	0.682	47.174	5.105	4.567	31.105	-6.798	9.111	-2.581	1.067	EML
404	MALE	2	90.0	3.83	3.85	50.144	50.380	7.107	7.125	93.021	93.257	0.596	0.622	48.905	5.493	5.267	29.712	-7.394	10.627	-2.756	1.067	EML
404	MALE	2	100.0	3.85	3.79	50.402	49.647	7.261	7.203	95.041	94.285	0.499	0.515	49.205	6.829	6.619	27.899	-8.951	15.208	-3.029	1.067	EML

ID	GRP	Order	Prescribed Work	Work (J)	Work (%)	AGE	HT (cm)	WT (kg)	Sex	TLC	FRC	FVC	MVV	P_B	TT Watts
405	MALE	2	0.0		0.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	
405	MALE	2	10.0		10.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	260.427
405	MALE	2	20.0		20.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	300.066
405	MALE	2	30.0		30.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	282.939
405	MALE	2	40.0		40.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	273.718
405	MALE	2	50.0		50.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	255.277
405	MALE	2	60.0		60.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	247.35
405	MALE	2	70.0		70.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	249.042
405	MALE	2	80.0		80.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	250.265
405	MALE	2	90.0		90.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	249.635
405	MALE	2	100.0		100.0	45	175.0	72.0	M	8.37	4.03	5.64	192	683.0	278.051
406	MALE	1	0.0		0.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	
406	MALE	1	10.0		10.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	234.853
406	MALE	1	20.0		20.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	233.287
406	MALE	1	30.0		30.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	249.656
406	MALE	1	40.0		40.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	255.6
406	MALE	1	50.0		50.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	262.126
406	MALE	1	60.0		60.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	258.667
406	MALE	1	70.0		70.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	258.667
406	MALE	1	80.0		80.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	259.403
406	MALE	1	90.0		90.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	262.949
406	MALE	1	100.0		100.0	42	192.0	92.9	M	10.77	5.42	7.46	228	675.0	352.57
411	MALE	2	0.0		0.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	.
411	MALE	2	10.0		10.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	215.51
411	MALE	2	20.0		20.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	229.02
411	MALE	2	30.0		30.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	235.321
411	MALE	2	40.0		40.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	236.753
411	MALE	2	50.0		50.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	237.896
411	MALE	2	60.0		60.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	235.322
411	MALE	2	70.0		70.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	235.694
411	MALE	2	80.0		80.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	237.291
411	MALE	2	90.0		90.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	239.107
411	MALE	2	100.0		100.0	49	174.5	68.8	M	8.40	4.89	5.09	198	684.0	241.9
414	MALE	2	0.0		0.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	.
414	MALE	2	10.0		10.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	170
414	MALE	2	20.0		20.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	199
414	MALE	2	30.0		30.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	199
414	MALE	2	40.0		40.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	199
414	MALE	2	50.0		50.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	199
414	MALE	2	60.0		60.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	196
414	MALE	2	70.0		70.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	194
414	MALE	2	80.0		80.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	191
414	MALE	2	90.0		90.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	192
414	MALE	2	100.0		100.0	46	174.5	68.2	M	7.23	3.01	4.31	158	672.0	202
415	MALE	2	0.0		0.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	.
415	MALE	2	10.0		10.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	304.702
415	MALE	2	20.0		20.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	332.196
415	MALE	2	30.0		30.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	337.582
415	MALE	2	40.0		40.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	334.053
415	MALE	2	50.0		50.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	327.388
415	MALE	2	60.0		60.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	318.698
415	MALE	2	70.0		70.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	312.382
415	MALE	2	80.0		80.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	308.38
415	MALE	2	90.0		90.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	300.586
415	MALE	2	100.0		100.0	20	186.0	84.8	M	8.69	4.34	7.31	176	686.0	307.793

ID	GRP	Order	Prescribed Work	V_E TT	V_E/MVV TT	V_T TT	f_B TT	VO_2 TT	VO_2 ml/kg TT	Peak VO_2 TT	PerVO_2 TT	VCO_2 TT	RER TT	V_E/VO_2 TT	V_E/VCO_2 TT	HR TT	PHR TT	HR PP TT	O2Pul TT	PetCO2 TT
405	MALE	2	0.0	16.34	8.51	0.82	19.93	0.44	6.1	3.92	11.19	0.40	0.92	37.24	40.43	73	175	41.71	6.012	41
405	MALE	2	10.0	100.35	52.27	2.99	33.79	3.24	44.9	3.92	82.48	3.25	1.00	31.02	30.90	138	175	78.86	23.443	38
405	MALE	2	20.0	117.27	61.08	3.03	38.68	3.691	51.3	3.92	94.11	3.74597	1.01	31.77	31.31	146	175	83.43	25.282	40
405	MALE	2	30.0	128.70	67.03	2.98	43.18	3.790	52.6	3.92	96.63	3.89297	1.03	33.96	33.06	154	175	88.00	24.609	38
405	MALE	2	40.0	127.42	66.36	3.16	40.29	3.865	53.7	3.92	98.55	3.903	1.01	32.96	32.65	157	175	89.71	24.620	38
405	MALE	2	50.0	129.19	67.29	3.14	41.21	3.797	52.7	3.92	96.81	3.77742	0.99	34.03	34.20	162	175	92.29	23.510	38
405	MALE	2	60.0	132.93	69.23	3.11	42.92	3.981	55.3	3.92	101.49	3.91559	0.98	33.39	33.95	165	175	94.29	24.125	35
405	MALE	2	70.0	129.25	67.32	3.08	42.06	3.847	53.4	3.92	98.07	3.77808	0.98	33.60	34.21	166	175	94.86	23.172	36
405	MALE	2	80.0	142.40	74.16	3.01	47.40	3.983	55.3	3.92	101.55	3.95666	0.99	35.75	35.99	167	175	95.43	23.851	34
405	MALE	2	90.0	148.24	77.21	3.13	47.44	4.101	57.0	3.92	104.56	4.02607	0.98	36.15	36.82	170	175	97.14	24.124	34
405	MALE	2	100.0	138.85	72.32	3.00	46.46	3.922	54.5	3.92	100.00	4.15815	1.06	35.40	33.39	172	175	98.29	22.802	.
406	MALE	1	0.0	10.91	4.79	1.27	8.92	0.37	4.0	4.86	7.61	0.34	0.93	29.52	31.83	74	183	40.44	4.996	40
406	MALE	1	10.0	94.49	41.44	4.38	21.97	3.25	35.0	4.86	66.84	3.16	0.97	29.09	29.87	141	183	76.91	23.081	42
406	MALE	1	20.0	96.03	42.12	3.91	24.61	3.378	36.4	4.86	69.52	3.19936	0.95	28.43	30.02	146	183	79.92	23.101	39
406	MALE	1	30.0	98.21	43.07	3.64	27.14	3.374	36.3	4.86	69.43	3.16155	0.94	29.10	31.06	147	183	80.12	23.014	39
406	MALE	1	40.0	109.11	47.86	3.86	28.40	3.562	38.3	4.86	73.29	3.39598	0.95	30.63	32.13	154	183	84.15	23.128	39
406	MALE	1	50.0	124.43	54.57	3.54	35.17	3.882	41.8	4.86	79.87	3.68716	0.95	32.05	33.75	158	183	86.34	24.569	35
406	MALE	1	60.0	115.95	50.86	4.12	28.77	3.633	39.1	4.86	74.74	3.48642	0.96	31.92	33.26	162	183	88.52	22.423	35
406	MALE	1	70.0	125.05	54.85	3.60	34.77	3.760	40.5	4.86	77.36	3.52034	0.94	33.26	35.52	161	183	87.70	23.426	38
406	MALE	1	80.0	131.86	57.83	3.61	36.50	3.953	42.6	4.86	81.34	3.71276	0.94	33.36	35.52	163	183	89.00	24.270	38
406	MALE	1	90.0	129.14	56.64	3.97	32.59	3.849	41.4	4.86	79.20	3.6217	0.94	33.55	35.66	167	183	91.12	23.083	32
406	MALE	1	100.0	207.37	90.95	4.23	49.09	4.870	52.4	4.86	100.20	5.2891	1.09	42.58	39.21	182	183	99.18	26.830	30
411	MALE	2	0.0	14.70	7.42	0.91	16.41	0.37	5.4	3.49	10.59	0.33	0.89	39.72	44.53	53	142	37.41	6.966	34
411	MALE	2	10.0	92.15	46.54	2.98	30.92	3.06	44.5	3.49	87.66	2.77	0.90	30.08	33.25	122	142	85.65	25.185	38
411	MALE	2	20.0	105.03	53.05	2.92	35.96	3.250	47.3	3.49	93.00	3.04405	0.94	32.32	34.50	130	142	91.73	24.950	36
411	MALE	2	30.0	107.03	54.06	2.95	36.23	3.311	48.2	3.49	94.76	3.11358	0.94	32.32	34.38	132	142	92.96	25.085	38
411	MALE	2	40.0	108.54	54.82	2.83	38.34	3.245	47.2	3.49	92.87	3.02977	0.93	33.44	35.82	134	142	94.37	24.218	35
411	MALE	2	50.0	111.44	56.28	2.89	38.59	3.328	48.4	3.49	95.23	3.0843	0.93	33.49	36.13	136	142	95.95	24.425	33
411	MALE	2	60.0	117.10	59.14	2.95	39.82	3.329	48.4	3.49	95.27	3.13862	0.94	35.17	37.31	136	142	95.77	24.480	32
411	MALE	2	70.0	115.48	58.32	2.87	40.28	3.333	48.5	3.49	95.39	3.0786	0.92	34.64	37.51	138	142	97.01	24.198	32
411	MALE	2	80.0	120.59	60.91	2.81	42.96	3.428	49.9	3.49	98.11	3.1463	0.92	35.17	38.33	140	142	98.42	24.532	32
411	MALE	2	90.0	120.36	60.79	2.81	42.78	3.396	49.4	3.49	97.17	3.12471	0.92	35.44	38.52	141	142	99.12	24.126	32
411	MALE	2	100.0	131.25	66.29	2.94	44.75	3.495	50.8	3.49	100.00	3.29905	0.94	37.56	39.78	142	142	100.00	24.609	32
414	MALE	2	0.0	8.05	5.09	0.47	16.99	0.17	2.5	2.80	5.97	0.17	0.99	48.07	48.45	72	159	44.97	2.342	35
414	MALE	2	10.0	78.74	49.84	1.89	41.78	2.65	38.8	2.80	94.48	2.41	0.91	29.72	32.65	142	159	89.31	18.659	40
414	MALE	2	20.0	84.11	53.23	1.78	47.32	2.725	40.0	2.80	97.18	2.47469	0.91	30.86	33.99	146	159	91.51	18.732	37
414	MALE	2	30.0	82.45	52.18	1.73	47.77	2.682	39.3	2.80	95.62	2.42538	0.90	30.75	34.00	147	159	92.14	18.304	37
414	MALE	2	40.0	90.70	57.41	1.91	47.44	2.755	40.4	2.80	98.23	2.56303	0.93	32.93	35.39	150	159	94.18	18.395	37
414	MALE	2	50.0	87.10	55.13	1.94	44.93	2.643	38.8	2.80	94.24	2.46644	0.93	32.96	35.32	150	159	94.26	17.634	37
414	MALE	2	60.0	87.02	55.08	1.79	48.54	2.409	35.3	2.80	85.92	2.29337	0.95	36.12	37.94	153	159	95.91	15.800	37
414	MALE	2	70.0	89.04	56.35	1.95	45.67	2.804	41.1	2.80	99.99	2.57694	0.92	31.75	34.55	152	159	95.28	18.510	37
414	MALE	2	80.0	85.58	54.17	1.95	43.99	2.526	37.0	2.80	90.06	2.30912	0.91	33.89	37.06	153	159	96.38	16.480	37
414	MALE	2	90.0	88.32	55.90	2.00	44.23	2.634	38.6	2.80	93.94	2.43871	0.93	33.53	36.22	155	159	97.56	16.983	35
414	MALE	2	100.0	106.30	67.28	1.86	57.16	2.804	41.1	2.80	100.00	2.71801	0.97	37.91	39.11	159	159	100.08	17.624	32
415	MALE	2	0.0	19.97	11.35	1.04	19.15	0.56	6.6	#REF!	#REF!	0.51	0.90	35.58	39.38	79	#REF!	#REF!	7.095	.
415	MALE	2	10.0	89.22	50.69	3.99	22.38	3.37	39.8	#REF!	#REF!	3.35	0.99	26.44	26.64	144	#REF!	#REF!	23.434	.
415	MALE	2	20.0	97.98	55.67	3.90	25.90	3.720	43.9	#REF!	#REF!	3.68613	0.99	26.34	26.58	155	#REF!	#REF!	24.017	.
415	MALE	2	30.0	98.00	55.68	3.60	27.22	3.551	41.9	#REF!	#REF!	3.45222	0.97	27.60	28.39	157	#REF!	#REF!	22.673	.
415	MALE	2	40.0	127.90	72.67	3.96	32.27	4.251	50.1	#REF!	#REF!	4.33677	1.02	30.09	29.49	168	#REF!	#REF!	25.358	.
415	MALE	2	50.0	119.53	67.91	3.85	31.04	4.020	47.4	#REF!	#REF!	3.9847	0.99	29.73	30.00	171	#REF!	#REF!	23.542	.
415	MALE	2	60.0	133.37	75.78	4.25	31.41	4.253	50.2	#REF!	#REF!	4.22909	0.99	31.36	31.54	173	#REF!	#REF!	24.656	.
415	MALE	2	70.0	142.44	80.93	4.43	32.15	4.536	53.5	#REF!	#REF!	4.54749	1.00	31.40	31.32	178	#REF!	#REF!	25.535	.
415	MALE	2	80.0	141.96	80.66	4.11	34.54	4.366	51.5	#REF!	#REF!	4.32175	0.99	32.51	32.85	176	#REF!	#REF!	24.773	.
415	MALE	2	90.0	160.69	91.30	3.41	47.12	4.291	50.6	#REF!	#REF!	4.21792	0.98	37.45	38.10	178	#REF!	#REF!	24.155	.
415	MALE	2	100.0	179.55	102.02	3.68	48.81	4.760	56.1	#REF!	#REF!	4.86701	1.02	37.72	36.89	182	#REF!	#REF!	26.156	.

ID	GRP	Order	Prescribed Work	PulseOx TT	HR Mech TT	RPE TT	RPB TT	RPU TT	LEG PAIN	Blood Lactate TT	Reason TT	Reason Code CPX	Peak V_E Mech	MinVI Mech TT	MinVE Mech TT	VE/MVV Mech TT	VT Mech TT	VT/FVC Mech TT	fB Mech TT	Avg IC TT	Typ IC TT
405	MALE	2	0.0	.	.	6	0.5	0	0	1.8	.	.	.	-18.271	19.048	9.921	1.091	19.350	17.718	2.69117	2.337
405	MALE	2	10.0	.	.	7	1	1	1	.	.	.	.	-114.935	115.143	59.970	3.120	55.323	36.953	3.79985	3.805
405	MALE	2	20.0	.	.	10	2	2	2	.	.	.	.	-123.913	124.416	64.800	3.179	56.369	39.242	3.90969	3.866
405	MALE	2	30.0	.	.	10	3	3	2	.	.	.	.	-130.728	130.028	67.723	3.149	55.833	41.253	3.95975	4.05
405	MALE	2	40.0	.	.	11	3	3	3	.	.	.	.	-130.970	131.352	68.412	3.221	57.111	40.782	3.93039	3.929
405	MALE	2	50.0	.	.	13	4	4	4	10.2	.	.	.	-139.172	139.076	72.435	3.147	55.795	44.277	3.84908	3.933
405	MALE	2	60.0	.	.	13	4	4	4	.	.	.	.	-141.023	142.934	74.445	3.143	55.733	45.462	3.76958	3.817
405	MALE	2	70.0	.	.	15	5	5	4	.	.	.	.	-140.856	141.015	73.445	3.204	56.812	44.029	3.9017	3.976
405	MALE	2	80.0	.	.	14	5	4	4	.	.	.	.	-145.261	145.397	75.728	3.218	57.064	45.194	3.92857	3.966
405	MALE	2	90.0	.	.	15	5	5	4	.	.	.	.	-150.025	150.018	78.135	3.222	57.119	46.639	3.81608	3.828
405	MALE	2	100.0	.	.	19	8	8	8	11	.	.	.	-159.700	160.251	83.464	2.913	51.646	54.984	4.01725	4.009
406	MALE	1	0.0	98	73	6	0	0	0	0.8	.	.	.	-13.761	13.762	6.036	1.417	18.997	9.999	3.5502	3.946
406	MALE	1	10.0	97	135	11	2	0.2	0	.	.	.	.	-98.903	97.782	42.887	3.761	50.412	23.716	5.49118	5.45
406	MALE	1	20.0	97	142	12	4	1	0.5	.	.	.	.	-98.167	98.715	43.296	3.947	52.905	25.070	5.3687	5.216
406	MALE	1	30.0	97	143	12	4	1	0.5	.	.	.	.	-101.860	103.020	45.184	3.796	50.882	27.235	5.3747	5.303
406	MALE	1	40.0	96	148	13	4	2	1	.	.	.	.	-116.310	117.730	51.636	3.749	50.257	31.552	5.2487	5.224
406	MALE	1	50.0	96	153	13	5	2	2	3.8	.	.	.	-127.140	126.940	55.675	3.608	48.361	35.266	5.3099	5.228
406	MALE	1	60.0	95	157	14	5	2	2	.	.	.	.	-139.880	140.500	61.623	3.730	49.995	37.842	5.3363	5.239
406	MALE	1	70.0	96	156	14	4	2	2	.	.	.	.	-130.510	130.970	57.443	3.632	48.692	36.159	5.3029	5.312
406	MALE	1	80.0	95	158	14	4	3	3	.	.	.	.	-135.050	136.170	59.724	3.713	49.767	36.683	5.308	5.458
406	MALE	1	90.0	95	162	15	5	3	3	.	.	.	.	-133.580	134.040	58.789	4.052	54.311	33.189	5.1643	5.074
406	MALE	1	100.0	94	179	19	8	4	4	8.2	.	.	.	-212.540	213.400	93.596	4.440	59.520	48.108	5.0073	4.98
411	MALE	2	0.0	98	49	6	0	0	0	0.8	.	.	.	-16.982	16.727	8.448	0.963	18.919	17.505	2.8297	2.771
411	MALE	2	10.0	97	110	8	1	1	0.5	.	.	.	.	-93.403	92.925	46.932	3.030	59.528	30.650	3.5837	3.596
411	MALE	2	20.0	96	121	9	1	1	1	.	.	.	.	-105.550	106.100	53.586	2.966	58.277	35.800	3.3538	3.439
411	MALE	2	30.0	96	126	10	2	2	1	.	.	.	.	-105.590	105.870	53.470	2.951	57.976	35.911	3.2442	3.168
411	MALE	2	40.0	96	128	12	2	2	2	.	.	.	.	-115.310	115.490	58.328	2.900	56.974	39.876	3.2751	3.286
411	MALE	2	50.0	95	130	13	3	3	2	2.7	.	.	.	-117.500	117.400	59.293	2.961	58.179	39.664	3.3458	3.284
411	MALE	2	60.0	95	130	14	4	4	3	.	.	.	.	-121.950	120.300	60.758	3.021	59.358	39.964	3.449	3.474
411	MALE	2	70.0	96	132	15	5	5	4	.	.	.	.	-119.370	118.810	60.005	2.944	57.831	40.435	3.3739	3.489
411	MALE	2	80.0	95	133	15	5	5	5	.	.	.	.	-125.060	125.220	63.242	2.876	56.499	43.576	3.3945	3.419
411	MALE	2	90.0	95	134	16	5	6	5	.	.	.	.	-123.600	123.150	62.197	2.865	56.285	43.052	3.3279	3.382
411	MALE	2	100.0	96	136	17	5	6	5	3.2	.	.	.	-137.430	136.880	69.131	3.013	59.189	45.617	3.5146	3.432
414	MALE	2	0.0	92	63	6	1	0	0	.	.	.	.	-18.871	18.714	11.844	1.404	32.578	13.688	1.26423	1.4531
414	MALE	2	10.0	92	136	13	4	3	0.5	.	.	.	.	-84.929	83.316	52.732	1.932	44.835	43.136	0.89371	0.936
414	MALE	2	20.0	88	141	15	5	3	1	.	.	.	.	-92.267	91.706	58.042	1.853	42.999	49.793	1.12941	0.9398
414	MALE	2	30.0	87	145	15	5	4	1	.	.	.	.	-92.763	92.635	58.630	2.049	47.541	45.247	0.90553	1.0707
414	MALE	2	40.0	87	154	15	5	4	2	.	.	.	.	-93.817	94.014	59.503	2.001	46.418	46.967	1.05311	0.8186
414	MALE	2	50.0	88	166	15	5	4	2	.	.	.	.	-92.049	92.062	58.267	2.055	47.670	44.977	1.08703	1.0563
414	MALE	2	60.0	89	151	16	7	4	2	.	.	.	.	-100.238	100.309	63.487	1.920	44.555	52.274	0.91875	0.7092
414	MALE	2	70.0	86	173	16	7	5	3	.	.	.	.	-96.055	95.280	60.304	2.064	47.881	46.284	0.95911	0.9111
414	MALE	2	80.0	87	163	16	7	6	3	.	.	.	.	-92.028	90.923	57.546	2.014	46.730	45.331	1.02215	0.8001
414	MALE	2	90.0	85	169	17	7	7	3	.	.	.	.	-96.006	95.654	60.541	2.078	48.204	46.112	1.00103	1.0591
414	MALE	2	100.0	89	159	17	8	7	2	.	.	.	.	-112.518	112.137	70.973	1.960	45.467	57.398	0.90335	1.2434
415	MALE	2	0.0	96	72	6	1	0	0	.	.	.	.	-23.133	23.411	13.302	1.122	15.354	20.958	4.00245	4.1371
415	MALE	2	10.0	96	139	13	4	3	3	.	.	.	.	-92.805	92.961	52.819	4.135	56.563	22.502	3.13955	3.5776
415	MALE	2	20.0	94	150	14	4	3	5	.	.	.	.	-103.003	103.301	58.694	4.387	60.016	23.533	2.50752	3.5716
415	MALE	2	30.0	93	151	15	5	4	5	.	.	.	.	-106.616	105.649	60.028	3.938	53.877	27.322	3.41887	3.8218
415	MALE	2	40.0	93	163	15	5	4	5	.	.	.	.	-131.654	132.943	75.536	4.123	56.401	32.266	2.87053	2.4555
415	MALE	2	50.0	93	165	15	5	4	6	.	.	.	.	-131.560	131.362	74.637	4.034	55.189	32.645	3.16022	3.4638
415	MALE	2	60.0	93	169	15	5	4	6	.	.	.	.	-140.775	141.025	80.128	4.447	60.835	31.702	2.60167	2.6116
415	MALE	2	70.0	92	173	15	6	5	7	.	.	.	.	-146.962	147.880	84.023	4.547	62.205	32.529	2.5402	2.3816
415	MALE	2	80.0	93	173	16	7	5	7	.	.	.	.	-153.636	154.650	87.869	4.315	59.027	35.955	2.82582	3.3227
415	MALE	2	90.0	93	175	16	7	6	7	.	.	.	.	-168.771	170.151	96.677	3.600	49.245	47.247	2.58533	2.5084
415	MALE	2	100.0	92	180	18	10	8	9	.	.	.	.	-187.535	189.289	107.550	3.839	52.514	49.312	3.03198	2.4746

A	B	C	D	BA	BB	BC	BD	BE	BF	BG	BH	BI	BJ	BK	BL	BM	BN	BO	BP	BQ	BR	BS
ID	**GRP**	**Order**	**Prescribed Work**	**EELVavg Mech**	**EELVtyp Mech TT**	**EELVavg %TLC**	**EELVtyp %TLC**	**EILVavg Mech TT**	**EILVtyp Mech TT**	**EILVavg %TLC**	**EILVtyp %TLC**	**Ti Mech TT**	**Te Mech TT**	**Ti/Ttot Mech TT**	**VT/Ti Mech TT**	**VT/Te Mech TT**	**PetCO2 Mech TT**	**Max Pi Mech TT**	**Max Pe Mech TT**	**Int MP**	**expBTPS Mech**	**Processing**
405	**MALE**	**2**	**0.0**	5.68	6.03	67.847	149.702	6.770	7.124	80.886	85.117	1.165	2.373	34.123	0.937	0.460	36.619	-1.750	1.924	-0.995	1.067	EML
405	**MALE**	**2**	**10.0**	4.57	4.57	54.602	54.540	7.690	7.685	91.880	91.819	0.727	0.902	44.660	4.291	3.460	38.875	-5.472	6.770	-2.488	1.067	EML
405	**MALE**	**2**	**20.0**	4.46	4.50	53.289	53.811	7.640	7.683	91.273	91.795	0.704	0.839	45.597	4.513	3.791	38.836	-5.869	7.140	-2.538	1.067	EML
405	**MALE**	**2**	**30.0**	4.41	4.32	52.691	51.613	7.559	7.469	90.314	89.235	0.671	0.786	46.046	4.694	4.006	38.333	-6.186	7.474	-2.575	1.067	EML
405	**MALE**	**2**	**40.0**	4.44	4.44	53.042	53.059	7.661	7.662	91.526	91.542	0.677	0.797	45.947	4.755	4.042	37.072	-5.919	7.729	-2.572	1.067	EML
405	**MALE**	**2**	**50.0**	4.52	4.44	54.013	53.011	7.668	7.584	91.610	90.607	0.617	0.743	45.368	5.104	4.237	35.574	-6.132	8.056	-2.579	1.067	EML
405	**MALE**	**2**	**60.0**	4.60	4.55	54.963	54.397	7.744	7.696	92.518	91.951	0.592	0.733	44.741	5.311	4.287	35.714	-6.398	8.298	-2.522	1.067	EML
405	**MALE**	**2**	**70.0**	4.47	4.39	53.385	52.497	7.672	7.598	91.666	90.779	0.611	0.756	44.743	5.246	4.241	35.625	-5.216	6.697	-2.244	1.067	EML
405	**MALE**	**2**	**80.0**	4.44	4.40	53.064	52.616	7.660	7.622	91.516	91.068	0.610	0.723	45.754	5.280	4.450	34.284	-3.540	6.562	-1.354	1.067	EML
405	**MALE**	**2**	**90.0**	4.55	4.54	54.408	54.265	7.775	7.764	92.897	92.754	0.571	0.719	44.256	5.642	4.479	33.259	-3.142	6.792		1.067	EML
405	**MALE**	**2**	**100.0**	4.35	4.36	52.004	52.103	7.266	7.274	86.805	86.904	0.520	0.576	47.637	5.601	5.059	32.851	-2.291	8.472		1.067	EML
406	**MALE**	**1**	**0.0**	7.22	6.82	67.036	125.904	8.637	8.241	80.195	76.520	2.387	3.711	39.227	0.594	0.382	37.249	-1.252	1.034	-1.887	1.067	EML
406	**MALE**	**1**	**10.0**	5.28	5.32	49.014	49.396	9.040	9.081	83.933	84.315	1.158	1.378	45.658	3.248	2.729	39.325	-4.144	4.416	-3.327	1.067	EML
406	**MALE**	**1**	**20.0**	5.40	5.55	50.151	51.569	9.348	9.501	86.797	88.214	1.096	1.310	45.553	3.600	3.012	38.854	-4.075	4.520	-3.124	1.067	EML
406	**MALE**	**1**	**30.0**	5.40	5.47	50.096	50.761	9.191	9.263	85.340	86.006	1.006	1.208	45.441	3.774	3.143	37.510	-4.205	4.853	-2.938	1.067	EML
406	**MALE**	**1**	**40.0**	5.52	5.55	51.266	51.495	9.271	9.295	86.077	86.306	0.863	1.051	45.061	4.343	3.567	35.991	-4.932	5.304	-3.003	1.067	EML
406	**MALE**	**1**	**50.0**	5.46	5.54	50.697	51.458	9.068	9.150	84.195	84.955	0.790	0.916	46.280	4.566	3.940	34.109	-5.270	6.089	-2.947	1.067	EML
406	**MALE**	**1**	**60.0**	5.43	5.53	50.452	51.356	9.163	9.261	85.082	85.985	0.725	0.869	45.517	5.142	4.291	32.976	-6.112	6.800	-3.103	1.067	EML
406	**MALE**	**1**	**70.0**	5.47	5.46	50.762	50.678	9.100	9.090	84.490	84.405	0.791	0.877	47.358	4.590	4.143	32.823	-5.408	6.795	-2.960	1.067	EML
406	**MALE**	**1**	**80.0**	5.46	5.31	50.715	49.322	9.175	9.025	85.187	83.794	0.754	0.885	45.980	4.922	4.193	32.413	-5.745	7.017	-3.052	1.067	EML
406	**MALE**	**1**	**90.0**	5.61	5.70	52.049	52.888	9.657	9.748	89.669	90.507	0.850	0.971	46.677	4.765	4.172	33.061	-5.840	7.246	-3.322	1.067	EML
406	**MALE**	**1**	**100.0**	5.76	5.79	53.507	53.760	10.203	10.230	94.734	94.988	0.584	0.665	46.782	7.601	6.682	29.624	-10.624	14.172	-4.218	1.067	EML
411	**MALE**	**2**	**0.0**	5.57	5.63	66.313	115.112	6.533	6.592	77.777	78.476	1.488	1.984	43.148	0.647	0.485	32.920	-1.471	1.408	-1.298	1.067	EML
411	**MALE**	**2**	**10.0**	4.82	4.80	57.337	57.190	7.846	7.834	93.408	93.262	0.978	0.984	49.816	3.099	3.080	37.196	-4.882	7.434	-2.674	1.067	EML
411	**MALE**	**2**	**20.0**	5.05	4.96	60.074	59.060	8.013	7.927	95.387	94.373	0.849	0.831	50.445	3.495	3.568	35.279	-5.165	7.799	-2.591	1.067	EML
411	**MALE**	**2**	**30.0**	5.16	5.23	61.379	62.286	8.107	8.183	96.510	97.417	0.865	0.812	51.568	3.413	3.633	35.526	-5.259	8.031	-2.586	1.067	EML
411	**MALE**	**2**	**40.0**	5.12	5.11	61.011	60.881	8.025	8.014	95.535	95.405	0.784	0.725	51.941	3.700	3.998	34.081	-5.568	8.818	3.275	1.067	EML
411	**MALE**	**2**	**50.0**	5.05	5.12	60.169	60.905	8.016	8.077	95.423	96.158	0.766	0.752	50.640	3.865	3.938	33.472	-5.296	9.065	-2.592	1.067	EML
411	**MALE**	**2**	**60.0**	4.95	4.93	58.940	58.643	7.972	7.947	94.908	94.611	0.769	0.740	51.002	3.930	4.083	32.207	-5.842	9.448	-2.709	1.067	EML
411	**MALE**	**2**	**70.0**	5.03	4.91	59.835	58.464	7.970	7.855	94.877	93.507	0.786	0.704	52.696	3.745	4.179	31.899	-5.556	9.609	-2.598	1.067	EML
411	**MALE**	**2**	**80.0**	5.01	4.98	59.589	59.298	7.881	7.857	93.825	93.533	0.705	0.674	51.130	4.077	4.269	31.202	-5.615	9.386	-2.531	1.067	EML
411	**MALE**	**2**	**90.0**	5.07	5.02	60.382	59.738	7.937	7.883	94.488	93.844	0.741	0.659	52.859	3.868	4.349	31.142	-5.772	10.419	-2.541	1.067	EML
411	**MALE**	**2**	**100.0**	4.89	4.97	58.160	59.143	7.898	7.981	94.025	95.008	0.679	0.643	51.396	4.438	4.685	29.650	-6.068	12.038	-2.711	1.067	EML
414	**MALE**	**2**	**0.0**	5.97	5.78	82.514	191.924	7.370	7.181	101.935	99.322	1.933	2.539	43.521	0.727	0.553	33.987	-1.555	1.211	-1.906	1.067	EML
414	**MALE**	**2**	**10.0**	6.34	6.29	87.639	87.054	8.269	8.226	114.366	113.781	0.604	0.795	43.236	3.201	2.430	37.439	-3.821	3.470	-1.638	1.067	EML
414	**MALE**	**2**	**20.0**	6.10	6.29	84.379	87.001	7.954	8.143	110.011	112.634	0.525	0.686	43.372	3.533	2.700	37.328	-4.055	3.744	-1.527	1.067	EML
414	**MALE**	**2**	**30.0**	6.32	6.16	87.475	85.191	8.374	8.208	115.816	113.531	0.599	0.729	45.117	3.421	2.810	36.202	-3.849	3.961	-1.674	1.067	EML
414	**MALE**	**2**	**40.0**	6.18	6.41	85.434	88.678	8.177	8.412	113.105	116.349	0.561	0.721	43.809	3.568	2.774	35.673	-4.054	3.957	-1.643	1.067	EML
414	**MALE**	**2**	**50.0**	6.14	6.17	84.965	85.390	8.198	8.228	113.383	113.808	0.590	0.755	43.764	3.485	2.723	36.396	-4.059	4.096	-1.684	1.067	EML
414	**MALE**	**2**	**60.0**	6.31	6.52	87.293	90.191	8.232	8.441	113.853	116.751	0.519	0.630	45.206	3.700	3.050	33.519	-4.215	4.325	-1.570	1.067	EML
414	**MALE**	**2**	**70.0**	6.27	6.32	86.734	87.398	8.335	8.383	115.278	115.942	0.569	0.738	43.599	3.627	2.797	35.075	-4.213	4.651	-1.700	1.067	EML
414	**MALE**	**2**	**80.0**	6.21	6.43	85.862	88.934	8.222	8.444	113.719	116.791	0.594	0.743	44.357	3.392	2.709	34.967	-3.996	4.037	-1.670	1.067	EML
414	**MALE**	**2**	**90.0**	6.23	6.17	86.154	85.351	8.307	8.249	114.890	114.087	0.556	0.749	42.632	3.734	2.773	34.451	-4.310	4.106	-1.707	1.067	EML
414	**MALE**	**2**	**100.0**	6.33	5.99	87.506	82.802	8.286	7.946	114.610	109.907	0.459	0.592	43.692	4.273	3.308	31.786	-4.973	4.894	-1.621	1.067	EML
415	**MALE**	**2**	**0.0**	4.69	4.55	53.942	104.906	5.810	5.675	66.858	65.308	1.110	1.785	38.480	1.011	0.629	37.089	-1.446	1.370	-1.060	1.067	EML
415	**MALE**	**2**	**10.0**	5.55	5.11	63.872	58.831	9.685	9.247	111.452	106.411	1.297	1.374	48.575	3.189	3.010	44.603	-3.840	5.932	-3.243	1.067	EML
415	**MALE**	**2**	**20.0**	6.18	5.12	71.145	58.900	10.570	9.506	121.630	109.386	1.240	1.315	48.581	3.539	3.335	43.464	-4.488	7.035	-3.468	1.067	EML
415	**MALE**	**2**	**30.0**	5.27	4.87	60.657	56.021	9.210	8.807	105.978	101.342	1.038	1.234	46.163	3.793	3.190	41.189	-4.751	6.278	-3.157	1.067	EML
415	**MALE**	**2**	**40.0**	5.82	6.23	66.967	71.743	9.942	10.357	114.412	119.187	0.883	0.979	47.437	4.667	4.211	39.240	-5.201	9.426	-3.311	1.067	EML
415	**MALE**	**2**	**50.0**	5.53	5.23	63.634	60.140	9.564	9.261	110.058	106.565	0.867	0.980	46.991	4.652	4.119	37.649	-5.378	9.317	-3.287	1.067	EML
415	**MALE**	**2**	**60.0**	6.09	6.08	70.061	69.947	10.535	10.525	121.235	121.121	0.879	1.017	46.392	5.057	4.374	37.232	-6.498	10.624	-3.690	1.067	EML
415	**MALE**	**2**	**70.0**	6.15	6.31	70.769	72.594	10.697	10.856	123.096	124.921	0.839	1.011	45.356	5.418	4.499	37.118	-6.814	11.301	-3.813	1.067	EML
415	**MALE**	**2**	**80.0**	5.86	5.37	67.482	61.764	10.179	9.682	117.136	111.418	0.757	0.934	44.927	5.701	4.622	35.114	-7.113	11.398	-3.671	1.067	EML
415	**MALE**	**2**	**90.0**	6.10	6.18	70.249	71.135	9.704	9.781	111.674	112.559	0.591	0.681	46.455	6.092	5.286	30.729	-7.658	11.582	-3.115	1.067	EML
415	**MALE**	**2**	**100.0**	5.66	6.22	65.110	71.524	9.497	10.054	109.284	115.698	0.570	0.650	46.718	6.739	5.910	31.550	-9.067	12.615	-3.477	1.067	EML

Appendix B: Institutional Review Board Approval

Jonathon Stickford <stickfordjl@appstate.edu>

IRB Notice - 17-0302
1 message

IRB <irb@appstate.edu> Fri, Aug 4, 2017 at 8:30 AM
To: larsone@appstate.edu
Cc: fasczewskiks@appstate.edu, shanelyra@appstate.edu, stickfordjl@appstate.edu

To: Erica Larson
Health and Exercise Science
CAMPUS EMAIL

From: Lisa Curtin, PhD, IRB Chairperson
RE: Notice of IRB Approval by Full Board Review

STUDY #: 17-0302
STUDY TITLE: The effect of a moderate dose of caffeine on perception of breathlessness during a 20km time trial in trained male and female cyclists.
Submission Type: Initial
Approval Date: 8/04/2017
Expiration Date of Approval: 8/03/2018

The Institutional Review Board (IRB) reviewed this study at a convened meeting and approved this study for the period indicated above. IRB approval is limited to the activities described in the IRB approved materials, and extends to the performance of the described activities in the sites identified in the IRB application. In accordance with this approval, IRB findings and approval conditions for the conduct of this research are listed below.

Regulatory and other findings:

The IRB determined that this study involves more than minimal risk to participants.

All approved documents for this study, including consent forms, can be accessed by logging into IRBIS. Use the following directions to access approved study documents.

1. Log into IRBIS
2. Click "Home" on the top toolbar
3. Click "My Studies" under the heading "All My Studies"
4. Click on the IRB number for the study you wish to access
5. Click on the reference ID for your submission
6. Click "Attachments" on the left-hand side toolbar
7. Click on the appropriate documents you wish to download

Appendix C: Informed Consent Statement

Appalachian State University
Informed Consent for Participants in
Research Projects Involving Human Subjects

Title of Project: **The effect of caffeine on perception of breathlessness during a 20-km time trial in trained male and female cyclists.**

IRB Study #: 17-0302

A. Principal Investigator: Erica Larson, B.S. Email: larsone@appstate.edu

Advisor: Andrew Shanely, Ph.D. Email: shanelyra@appstate.edu
Advisor: Jonathon Stickford, Ph.D. Email: stickfordjil@appstate.edu
Advisor: Kym Fasczewski, Ph.D. Email: fasczewskiks@appstate.edu

Research Assistants: Jayvaughn Oliver, B.S. Email: oliverjt@appstate.edu

This is to certify that I, ____ have been given the following information with respect to my participation as a volunteer in a program of investigation under the supervision of Erica Larson B.S. to which Andrew Shanely Ph.D., and Jayvaughn Oliver may be assisting.

1. **Purpose of the study:**

Caffeine is a legal, widely used drug which aids in enhancing exercise performance. Moderate to high intensity exercise is associated with naturally occurring pain in the muscles that are activated. Caffeine can modify pain perception during exercise, leading to increases in performance. Increases in exercise intensity will result in increases in ventilation. Increases in ventilation can lead to feelings of breathlessness while exercising. This study will contribute to how we understand caffeine helps us work harder. Discovering another potential way, as to how caffeine can enhance performance, is important to athletes who consume caffeine.

The purpose of this study is to measure the rate of perceived breathlessness after the taking of a moderate dose of caffeine in trained male and female cyclists, while also measuring differences in pain perception and performance.

2. **Inclusion Criteria: You may participate in the study if the following apply to you:**

- Sex: Males and Females will be included in the study.
- Ethnicity: Any.
- Age: 18 – 50 years of age
- Interest in participating in the research study.
- Train as a cyclist by riding a bicycle for at least three hours per week.
- Have a relative VO_{2max} of at least 53ml/kg/min (males), 48ml/kg/min (females).
- Understand written and oral instructions in English.
- Provide informed consent.
- Available during times the data collection is offered.
- Have normal lung function.
- Have smoked less than a half a pack of cigarettes per day for one year.
- If female:
    - Not pregnant or planning on becoming pregnant.
    - Taking oral contraceptives.
- Consuming $\leq$ 4 cups of coffee daily.

<u>Exclusion Criteria: You should not participate in this study if any of the following apply to you:</u>

- Known cardiovascular, metabolic or renal disease, or signs/symptoms suggestive of cardiovascular, metabolic or renal disease.
- Train less than 3 hours per week as a cyclist by riding a bicycle.
- Have a relative VO_{2max} less than 53ml/kg/min (males), 48ml/kg/min (females)
- Do not have normal lung function.
- Have smoked more than a half a pack of cigarettes per day for one year.
- If female:
    - Pregnant or planning on becoming pregnant.
    - Not taking oral contraceptives.
- Hypersensitive to caffeine, defined below.
- Consuming >4 cups of coffee daily.

3. <u>Procedures:</u> ***Please read the descriptions of each experimental day and write your initials in the space provided.***

You could be asked to repeat a trial, procedure, or test. This could happen for many reasons such as equipment failure, power outage, inconclusive test results, etc. However, you do not have to repeat a trial, procedure, and/or test if you do not wish to do so.

Below is a timeline showing all visits and experiments which you will complete in this study.

Visit 1	Visit 2	Visit 3-4
Informed Consent Medical & Exercise History Pulmonary Function Test Body Composition VO_{2max} test	20-km Familiarization Time Trial	20-km Time Trial Caffeine or Placebo

________**initial** **<u>Prescreen:</u>** You may be telephoned by the Principle Investigator or a Research Assistant (see page 1) and asked screening questions to determine your eligibility for the study.

Visit 1:

________ **initial** **<u>Consent and Questionnaires:</u>** Potential participants who meet inclusion criteria will be invited to a screening interview within the laboratory located off campus (Charleston Forge Research Site). At this screening visit, the study will be explained in-depth to you by the PI or a trained research assistant. You will be provided time to consider your options and get all questions answered - if you agree to participate, you will then provide your written informed consent.

After you have provided consent (~30 minutes), you will be asked to complete questionnaires: 1) a medical history questionnaire (~10 minutes) and 2) an exercise history questionnaire (~10 minutes).

________ **initial** **<u>Pulmonary Function Testing (PFT)</u>:** You will be asked to perform tests of breathing function. The protocol will follow that described by the American Thoracic Society. These tests include measurement of the total volume of air your lungs can hold, the volume of air that you can push out with one maximal breath, the volume of air that you can forcefully breathe out in one second, and the maximum volume of air that you can breathe in 12 seconds. For all these procedures, you will wear a nose clip and breathe through a disposable mouthpiece. These procedures will take ~45 minutes total.

_________**initial** **<u>Body Composition:</u>** Following completion of the questionnaires, we will measure your height, weight, waist circumference, and body composition. Your percent body fat will be measured using a Bod Pod plethysmograph. You will sit in a chamber and may hear some clicking while air pressure changes to estimate your body volume. This piece of equipment estimates your body's composition of fat and muscle by air movement. This is accomplished by measuring your mass (scale) and body volume (relationship between pressure and volume in chamber) and entering it into a calculation for fat mass and fat free mass (muscle). This is an extremely accurate method and presents no risk. These procedures will take ~15 minutes total

________ **initial** **<u>Maximal Aerobic Capacity Exercise Test ($\dot{V}O_{2max}$)</u>:** You will be asked to perform a maximal exercise test to examine your cardiovascular fitness. This test will measure your highest exercise capacity and is often described as a $\dot{V}O_{2max}$ test. You should be rested, well nourished, and hydrated for the test and avoid caffeine, and tobacco 3 hours before the test, and refrain from alcohol for 12 hours before the test. Avoid significant exertion or exercise the day of testing and report any medication that you are using to the testing staff before the test. When you are ready to perform the test, the investigators will help with necessary adjustments to testing equipment to assure your comfort. You will be fitted with a rubber mouthpiece and nose clip. Your breathing pattern, exercise metabolism, exhaled carbon dioxide, and arterial blood oxygen level (via pulse oximetry) will be monitored during the test. This procedure will require ~45 minutes total, with exercise lasting approximately 15 minutes.

Cycling Protocol

You will perform cycling exercise on a stationary bicycle. Prior to exercise, you will rest sitting on the bike with both hands on the handle bars for 5 minutes. You will breathe through a mouthpiece and wear a nose clip during the test. Your breathing pattern, exercise metabolism, exhaled carbon dioxide, and arterial blood oxygen level (via pulse oximetry) will be monitored during the test.

Pulse oximetry is a method of determining the amount of oxygen in the blood by using a sensor placed on the skin (e.g., forehead). Throughout the test, you will be asked about your perceptual responses (e.g., ratings of perceived breathlessness, unpleasantness of breathlessness, perceived exertion and leg muscle pain) to the exercise. You will be asked to rate your breathing by pointing with your finger to a number on a scale, which will represent your perceived level of breathlessness. The number will be repeated out loud in order to confirm your choice. During the exercise you may have an even stronger or greater intensity of breathlessness than you have previously experienced. If this occurs, you should point to the word "maximal" if the severity is greater than 10. After the mouthpiece is removed, you can tell us the number. A small blood sample (a few drops) for blood lactate will be obtained by sticking your finger. You may stop exercise when you wish, because of personal feelings of fatigue or discomfort. Following completion of the test, you will perform a light intensity cool-down.

Flow-Volume Loops

During the maximal exercise test, the speed at which you breathe air in and out and the volume of air you breathe will be measured. Approximately once every 60 seconds during the exercise test, you will be prompted to breathe in completely, filling your lungs with air, and then return to normal breathing. Before and after the exercise test, while at rest, you will be prompted to perform 3 breathing maneuvers, where you complete a maximal inhalation (filling your lungs completely with air) followed by a complete exhalation (breathe out all the air you can). The investigators will coach you through these maneuvers. These procedures are performed during the maximal exercise test, and add no additional time.

Visit 2-4:

________ initial **<u>Nutrition Recall</u>:** You will be asked to record all foods and supplementation you consume during the three days leading to visits 3 & 4.

________ initial **<u>Caffeine Recall</u>**: You will be asked to record all caffeine you consume during the 7 days leading to visits 3 & 4. A list of popular items that contain caffeine will be provided for you.

________ initial **<u>20km Time Trial</u>:** A standardized 10-min warm-up will be allowed before each trial. You will complete a 20km time trial under placebo (P) and caffeine (CAF) conditions in a random order. You will be given instructions to complete the distance in as fast of a time as possible. The same range of gear ratios will be used for each trial and you will be permitted to adjust this throughout the trial. The elapsed time will be recorded and used for comparison. A minimum of 48 hours will be between visit 2 and 3 and visit 3 and 4.

________ initial **<u>Caffeine Consumption:</u>** A dose of 5 mg/kg body weight of caffeine will be administered orally to you on one visit. This is approximately equal to two to three cups of coffee. Caffeine will be administered orally via a vegan capsule. The placebo will be gluten free flour and will also be administered orally via a vegan capsule.

________ initial **<u>Finger Blood Lactate Test</u>**: A finger stick will be used to collect a small blood sample (a few drops) to measure your blood lactate prior to the start of cycling, halfway during the 20-km time trial and approximately 5 minutes post completion of each 20k time trial.

________ **initial** **Breathlessness Questionnaire**: Following the exercise tests, you will be asked to complete a questionnaire about the breathing sensations that you experienced during exercise. During this "debriefing session" we will give you a questionnaire including 15 respiratory sensation descriptors to describe the respiratory sensations you were most often experiencing (e.g., respiratory work/effort, air hunger, and/or chest tightness).

3. Discomforts and risks:

There are minimal risks involved with measuring/monitoring/performing: questionnaires, physical characteristics, body composition, activity assessment, pulmonary function testing, flow-volume loops, and breathlessness during exercise.

Maximal Aerobic Capacity Exercise Test (VO_{2max}): VO_{2max} test risks include abnormal heart beats, abnormal blood pressure responses, muscle cramps, muscle strain and/or joint injury, delayed muscle soreness (1 to 2 days afterwards), light headedness, fatigue, and in rare instances, heart attack. Men $\geq$ 45 years old, are at a higher risk for developing cardiovascular disease, which include coronary heart disease, heart failure, peripheral vascular disease and stroke. These may increase your risk for a cardiovascular event to occur.

Caffeine Consumption: Consuming caffeine may cause symptoms of caffeine hypersensitivity that include feelings of nervousness, restlessness, upset stomach, fast heartbeat, and insomnia. If any of these symptoms are felt, and the discomfort is too great, you can remove yourself from the study. You will be screened prior to entering the study to ensure you are not hypersensitive to caffeine.

Finger Blood Lactate Test: Collection of finger blood lactate may cause minimal local pain and discomfort. There is a very small risk of infection. If the discomfort is too great, you can refuse to provide a blood sample. The sample site will be cleansed with an alcohol swab prior to sample collection. A new single-use lancing stick will be used for every sample collected.

Loss of Confidentiality: Any time information is collected; there is a potential risk for loss of confidentiality. Every effort will be made to keep your information confidential; however, this cannot be guaranteed.

Other Risks: There may possibly be other side effects that are unknown at this time. If you are concerned about other, unknown side effects, please discuss this with the researchers.

How you can help reduce some of the risks: During your participation in this research, the researchers will closely observe your testing to determine whether there are problems that need medical care. It is your responsibility to do the following:

- Ask questions about anything you do not understand.
- Keep appointments.
- Follow the study researchers' instructions.
- Let the researchers know if your telephone number changes.
- Tell the researchers before you take any new medication.
- Tell your regular doctor about your participation in this research.
- If female, inform the researchers if you become pregnant.

4. a. Benefits to you: You can expect to receive knowledge of your lung function, cardiovascular conditioning, and cardiovascular fitness. We are performing these tests for research purposes only. The information collected is not intended for diagnostic or therapeutic purposes. Under no circumstance will the investigator or research staff interpret results as normal or abnormal. We are unable to make any medical comments about your results. The results will not be looked at for medical diagnostic or medical treatment purposes.

b. Potential benefits to society: The knowledge gained from this study serves great clinical significance regarding how people who consume caffeine may alter their own breathing efforts during exercise.

5. **Alternative procedures that could be utilized:** Not participating in the study. The procedures used in this study are frequently used in research and are the most appropriate methods to accomplish the goals of this research.

6. **Time duration of the procedures and study:**

You will need to visit the Charleston Forge Laboratory for the following:

________ initial Visit 1 (about 1.5 - 2 hrs)

________ initial Visit 2 (about 1 hour).

________ initial Visit 3 (about 2 hours).

________ initial Visit 4 (about 2 hours).

Approximately 7 hours Total

7. **Statement of confidentiality:** Volunteers are coded by an identification number for statistical analyses. All records are kept in a secure location. All records associated with your participation in the study will be subject to the university confidentiality standards and in the event of any publication resulting from the research no personally identifiable information will be disclosed. The Office of Human Research Protections in the U.S. Department of Health and Human Services, the U.S. Food and Drug Administration (FDA), the Office for Research Protections at Appalachian State University and the Institutional Review Board may review records related to this project.

8. **Right to ask questions:** Please contact Erica Larson B.S. (larsone@appstate.edu, c. 814-860-6631) or Andrew Shanely (shanelyra@appstate.edu, 828-262-6319), with questions, complaints, or concerns about this research. If you have any questions about your rights as a research subject, please contact the IRB Administrator at the Appalachian State University Institutional Review Board Office at (828) 262-2692, irb@appstate.edu. This study has been approved on 1/17/2018 by the Institutional Review Board (IRB) at Appalachian State University. This approval will expire on 8/3/2018 unless the IRB renews the approval of this research.

9. **Compensation:** You will receive a total of $42 upon completion of this study: **Compensation Breakdown:** You will receive $21 per experimental protocol completed (each of Visits 3 and 4). Total: $42

You may be asked to repeat a trial. If you agree to repeat a trial, you will be paid for the repeated trial as stated above.

10. **Injury Clause:** In the unlikely event you become injured as a result of your participation in this study, standard emergency procedures will be followed. If you get hurt or sick when you are not at the research site, you should call your doctor or call 911 in an emergency. If your illness or injury could be related to the research, tell the doctors or emergency room staff about the research study, the name of the Principal Investigator, and provide a copy of this consent form if possible. Please contact the PI as soon as possible (Erica Larson B.S. larsone@appstate.edu, c. 814-860-6631) or Andrew Shanely (shanelyra@appstate.edu, 828-262-6319). It is the policy of this institution to provide neither financial compensation nor free medical treatment for research-related injury. You will be responsible for any costs for medical care not paid by your insurance company. No other compensation is offered by Appalachian State University. By signing this document, you are not waiving any legal rights that you have against Appalachian State University for injury resulting from negligence of the University or its investigators.

11. **Voluntary participation:** Your participation in this study is voluntary. You may withdraw from this study at any time by informing the research personnel. You may decline to answer certain questions and may decide not to comply with certain procedures. However, your being in the study may be contingent upon answering these questions or complying with the procedures. The researcher may end your role in the study without your consent if the researcher deems that your health or behavior adversely affects the study or increases risks to you beyond those approved by the Institutional Review Board and agreed upon by you in this document. You have been given an opportunity to ask any questions you may have, and all such questions or inquiries have been answered to your satisfaction.

____

Volunteer

Date

I, the undersigned, have defined and explained the studies involved to the above volunteer.

____

Person Obtaining Consent

Date

Appendix D: Telephone Screening Form

Initial Telephone Screening Form for Cycling Study

General Information:

Name: ____

Email: ____

Address (if no email): ________________________________

Age: _________ Sex: _________ Phone: ________________

Height: _______ Weight: _______ Allergies (latex?)_________

Exclusion Criteria: any question answered "yes" in this section will disqualify the potential subject.

	Yes	No	
1.	☐	☐	Age – outside the ages of 18 and 50 yr?
2.	☐	☐	Do you currently smoke tobacco cigarettes? Any history of smoking? If so, how much did you smoke and for how long? (Must be less than 0.5 pack·yrs)
3.	☐	☐	Have you ever been diagnosed with a sleep disorder or use CPAP?
4.	☐	☐	Do you have a history of asthma, COPD, or any lung issues?
5.	☐	☐	Do you have a history of an irregular heartbeat or any heart condition? (Have you had an EKG performed?)
6.	☐	☐	Do you have any known metabolic or renal diseases?
7.			Do you have any known health conditions?
	☐	☐	High blood pressure?
	☐	☐	Diabetes?
	☐	☐	Thyroid issues?
8.	☐	☐	If female, are you pregnant?
9.	☐	☐	Do you consume >4 cups of coffee daily?

Inclusion Criteria: any question answered "yes" in this section will qualify the potential subject

	Yes	**No**	
1.	☐	☐	Do you train as a cyclist by riding your bicycle ≥ 3 hours per week?

2. How many hours do you cycle per week? _________________

Appendix E: Exercise Log

Date: ________________________________

Mileage: ______________________________

Exercise Time: __________________________

Intensity of Exercise
(6=rest → 20=maximal): ___________________

Comments:

Date: ________________________________

Mileage: ______________________________

Exercise Time: __________________________

Intensity of Exercise
(6=rest → 20=maximal): ___________________

Comments:

Date: ________________________________

Mileage: ______________________________

Exercise Time: __________________________

Intensity of Exercise
(6=rest → 20=maximal): ___________________

Comments:

Appendix F: Nutrition Log

Time Food/Beverage Consumed	Food Item and Method of Preparation	Amount Eaten (in cups, tablespoons, ounces, etc.)

Appendix G: Caffeine Recall

7-Day Caffeine Recall

ID#__________________ Study ____________ Trial _____________Date_______________

Date	Amount consumed	Type of Caffeine Consumed

Appendix H: Rating of Breathlessness Questionnaire

Subject:______ Date: ___________ Test: ______________ RPB: _________

<u>STANDARD RESPIRATORY DEBRIEFING (Original A):</u>

Look over the following symptom list and select (circle) the **<u>top 3 descriptors</u>** that best describe the respiratory sensations you felt during the exercise.

1. My breath does not go in all the way.
2. My breathing requires effort.
3. I feel that I am smothering.
4. I feel hunger for air.
5. My breathing is heavy.
6. I feel out of breath.
7. My chest feels tight.
8. My breathing requires work.
9. I feel that I am suffocating.
10. My chest is constricted.
11. I feel that my breathing is rapid.
12. My breathing is shallow.
13. I feel that I am breathing more.
14. I cannot get enough air.
15. My breath does not go out all the way.

Appendix I: Visual Analog Scale Questionnaire

Subject:______ Date: ___________ Test: ______________ RPB: _____________

1) Indicate along the scale below how unpleasant or disturbing your breathlessness was **when your rating was highest.**

Not bad at all —————————————— Maximal imaginable

2) What kind of negative feelings accompany your breathlessness? Check along each scale below the intensity of each feeling as it related to your breathlessness **when your rating was highest**.

	None	Maximal imaginable
Depression		
Anxiety		
Frustration		
Anger		
Fear		
	None	Maximal imaginable

Appendix J: Rating of Perceive Breathlessness Scale

Rate of Perceived Breathlessness (RPB)	
0	Nothing at all
0.5	Very, very weak (just noticeable)
1	Very weak
2	Weak (light)
3	Moderate
4	Somewhat strong
5	Strong (heavy)
6	
7	Very strong
8	
9	
10	Very, very strong (almost max) maximal

Appendix K: Rating of Perceived Breathlessness Description

This is a scale for rating:

BREATHLESSNESS

The number 0 represents no breathlessness. The number 10 represents the strongest or greatest breathlessness that you have ever experienced. Each minute during the exercise test you will be asked to point to a number, with your finger, which represents your perceived level of breathlessness at the time. The number will be repeated out loud in order to confirm your choice. During the exercise test you may have an even stronger or greater intensity of breathlessness than you have previously experienced. You should then point to the word “maximal” if the severity is greater than 10. You can tell us this number after the mouthpiece has been removed.

Appendix L: Rating of Perceived Unpleasantness Scale

Rate of Unpleasantness (RPU)	
0	Not unpleasant
0.5	Very, very weak (just noticeable)
1	Very weak unpleasantness
2	Weak (light) unpleasantness
3	Moderate unpleasantness
4	Somewhat strong unpleasantness
5	Strong (heavy) unpleasantness
6	
7	Very unpleasant
8	
9	
10	Maximal imaginable unpleasantness

Appendix M: Rating of Unpleasantness Description

This is a scale for rating:

UNPLEASANTNESS
OF
BREATHLESSNESS

Unpleasantness expresses the affective evaluation of the sensation regardless of whether the intensity is high or low. Unpleasantness describes how much you affectively dislike something or feel terrified by it. A low unpleasantness indicates that the perceived breathlessness does not feel bad. A high unpleasantness signifies that the breathlessness feels very bad or terrifying regardless of whether the intensity of the sensation is high or low.

During the exercise test you will be asked to point to a number, with your finger, which represents your perceived level of the unpleasantness of breathlessness at the time. The number will be repeated out loud in order to confirm your choice.

Appendix N: Rating of Perceived Exertion Scale

Rate of Perceived Exertion	
6	No exertion at all
7	
8	Extremely Light
9	
10	
11	Light
12	
13	Somewhat Hard
14	
15	Hard (heavy)
16	
17	Very Hard
18	
19	Extremely Hard
20	Maximal exertion

Appendix O: Rating of Perceived Exertion Description

This is a scale for rating:

PERCIEVED EXERTION

During the graded exercise test we want you to pay close attention to how hard the work rate is for you. The feeling should be your total amount of exertion and fatigue, combining all sensations and feelings of physical stress, effort and fatigue. Don't concern yourself with any one factor such as leg pain, shortness of breath or exercise intensity, but try to concentrate on your total, inner feeling of exertion. Don't underestimate or overestimate, just be as accurate as possible.

Appendix P: Leg Muscle Pain Scale

Leg Muscle Pain Rating	
0	No pain at all
0.5	Very faint pain (just noticeable)
1	Weak Pain
2	Mild Pain
3	Moderate Pain
4	Somewhat strong pain
5	Strong pain
6	
7	Very strong
8	
9	
10	Extremely intense pain (almost unbearable)

Appendix Q: Leg Muscle Pain Description

Leg Muscle Pain Instructions

You are about to undergo an exercise test. The scale before you contains the numbers 0-10. You will use this scale to assess perceptions of pain in your legs during and after the exercise test. In this context, pain is defined as the intensity of hurt that you feel. Don't underestimate or overestimate the degree of hurt you feel, just try to estimate it as honestly and objectively as possible.

The numbers on the scale represent a range of pain intensity from“very faint pain” (number 1/2) to “extremely intense pain-almost unbearable” (number 10). When you feel no pain in your legs, you should respond with the number 0.

Repeatedly during the test you will be asked to rate the feelings of pain in your legs. When rating these pain sensations, be sure to attend only to the specific sensations in your legs and not report other pains you may be feeling(e.g., seat discomfort).

It is very important that your ratings of pain intensity reflect only the degree of hurt you are feeling in your legs either during exercise or following exercise as pain perceptions are abating. Do not use your ratings as an expression of fatigue (i.e., inability of the muscle to produce force) or relief that the exercise task is completed.

In summary you will be asked to: (i) provide pain intensity ratings in your legs only; (ii) give ratings as accurately as possible; and (iii) not under- or overestimate the pain, but simply rate your pain honestly. You should use the verbal expressions to help rate your perceptions.

Cook et al., 1997

Vita

Erica Marie Larson was born in Erie, Pennsylvania to Drew and Mary Larson. She graduated from James Madison University in Harrsionburg, Virginia in August 2016 with a Bachelor of Science in Kinesology. The following autumn, she entered Appalachian State University to study Clinical Exercise Science. She will graduate with a Masters' of Science in May 2018. Upon graduation, Ms. Larson has accepted a job with the Paul H. Broyhill Wellness Center where she will be working as an Exercise Physiologist. She will has be an Adjunct Professor within the Health and Exercise Science Department at ASU in the fall.

Ms. Larson currently lives in Boone, North Carolina. During her free time, she enjoys riding her bike, tending to her plants and being outside as much as possible.